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TRAVELS
IN THE
TWO SICILIES,
AND
SOME PARTS OF THE APENNINES,

Translated from the Original Italian of the
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Padua, &c. &c.

IN FOUR VOLUMES.—WITH ELEVEN PLATES.

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TRAVERS

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SOME PARTS OF THE APPENDICES.

Printed from the Original Edition of the

ABBE LANTATO STAMMAMI

1. The first of the three main points of the report is that the Government has failed to do its duty in the past. This is a very serious charge, and it is one which the Government must not ignore. The second point is that the Government has failed to do its duty in the future. This is also a very serious charge, and it is one which the Government must not ignore. The third point is that the Government has failed to do its duty in the present. This is also a very serious charge, and it is one which the Government must not ignore.

THE UNIVERSITY OF CHICAGO

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TRAINING FOR THE FUTURE

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CONTENTS

OF THE

SECOND VOLUME.

	Page
<i>THE Lipari Islands—Introduction</i>	I
CHAP. X.— <i>Stromboli</i> — —	5
CHAP. XI.— <i>Stromboli continued</i> —	72
CHAP. XII.— <i>Basiluzzo, Bottero, Lisca- Bianca, Dattola, Panaria, Saline</i>	141
CHAP. XIII.— <i>Vulcano</i> — —	172
CHAP. XIV.— <i>Vulcano continued</i> —	221
CHAP. XV.— <i>Lipari—Observations made round the Skores of the Island</i> — —	257

CONTENTS

OF THE

SECOND VOLUME

THE FIRST BOOK—Introduction	1
CHAP. I.—General Principles	1
CHAP. II.—Of the Nature and Extent of the Law	12
CHAP. III.—Of the Rights of Man	12
CHAP. IV.—Of the Rights of Man continued	12
CHAP. V.—Of the Rights of Man	12
CHAP. VI.—Of the Rights of Man	12
CHAP. VII.—Of the Rights of Man	12
CHAP. VIII.—Of the Rights of Man	12
CHAP. IX.—Of the Rights of Man	12
CHAP. X.—Of the Rights of Man	12
CHAP. XI.—Of the Rights of Man	12
CHAP. XII.—Of the Rights of Man	12
CHAP. XIII.—Of the Rights of Man	12
CHAP. XIV.—Of the Rights of Man	12
CHAP. XV.—Of the Rights of Man	12
CHAP. XVI.—Of the Rights of Man	12
CHAP. XVII.—Of the Rights of Man	12
CHAP. XVIII.—Of the Rights of Man	12
CHAP. XIX.—Of the Rights of Man	12
CHAP. XX.—Of the Rights of Man	12
CHAP. XXI.—Of the Rights of Man	12
CHAP. XXII.—Of the Rights of Man	12
CHAP. XXIII.—Of the Rights of Man	12
CHAP. XXIV.—Of the Rights of Man	12
CHAP. XXV.—Of the Rights of Man	12
CHAP. XXVI.—Of the Rights of Man	12
CHAP. XXVII.—Of the Rights of Man	12
CHAP. XXVIII.—Of the Rights of Man	12
CHAP. XXIX.—Of the Rights of Man	12
CHAP. XXX.—Of the Rights of Man	12

TRAVELS

IN THE

TWO SICILIES, &c.

THE LIPARI ISLANDS.

INTRODUCTION.

The volcanization of these islands known to the ancients, and studied by several of the moderns—A wide field for observation, nevertheless, left to others—Felicuda, and Alicuda, two of these islands, first examined by the author.

THE Lipari Islands are situated in the Mediterranean, between Sicily and Italy, and are called the Eolian isles, from Æolus
to VOL. II. B their

their reputed king, but more generally the Lipari islands, from the name of the principal and largest. Though they were anciently known to be volcanic, and therefore were called vulcanian, it is only in modern times that their volcanization has been considered as an interesting object of the researches of the philosopher, who labours to promote the knowledge of nature. M. de Luc, Sir William Hamilton, and the Commendator Dolomieu, in this respect, particularly deserve notice.

The former of these naturalists, in the year 1757, visited Volcano, one of these islands, and made a number of observations; especially with respect to the principal circumstances relative to its extensive crater.

The same island, as well as that of Stromboli, exercised the curiosity of Sir William Hamilton; though he only saw it at a distance, as he was returning, from Messina to Naples, in the year 1768. The accounts of

of these two writers will be related and examined in their respective places.

But much more complete and interesting, relative to volcanic enquiries, is the information we received from the Commendator Dolomieu, in his work entitled *A Voyage to the Lipari Islands* *. The field, however, in which he laboured is so extensive and productive, that there is still room for new and abundant harvests. These islands are ten in number, and he remained there only eight days, circumstances, perhaps, not permitting him a longer stay. Some of them, it is true, are very small; yet others would require many weeks to examine them minutely. Among the latter is the island of Lipari, which is nineteen and a half Italian miles in circuit.

These considerations, therefore, far from causing me to abandon my design of visiting and examining these countries, rather increased my desire to carry my plan into

* Viaggio alle Isole di Lipari.

execution ; and the work of M. Dolomieu itself gave the last impulse to my determination. With a candour worthy of himself, he thus concludes his observations : “ In the description I have given of the Eolian isles, I do not pretend that I have been able to point out every thing interesting which they contain, or entirely exhausted the subject ; I rather hope that I shall excite other travellers, who have more time at their disposal, to examine them with attention ; in which case, I can assure them, they will be rewarded with a much more abundant harvest than that I have reaped.”

I shall conclude with adding that two of these islands, Felicuda and Alicuda, were not visited by this naturalist ; and it was no small gratification to me to recollect that I was the first who had examined them. Wherever I have been preceded by M. Dolomieu, I shall not fail to notice it to the reader ; and, while I relate my own observations, shall be careful to do justice to his discoveries.

CHAP. X.

STROMBOLI.

The fires of this volcano visible, by night, at the distance of a hundred miles—Their apparent intermissions—Intermissions in the smoke seen by day—Shoals of dolphins met with near this island—Appearances observed in the smoke of the volcano, when seen at a small distance—Explosions of the volcano—The alterations in the volcano symptoms of the changes of the atmosphere, according to the opinion of the people of Stromboli—Signs of good and bad weather deduced from these alterations—Observations on these prognostics, made by the author, during a stay of five-and-thirty days—Phenomena of the volcano observed at the distance of two miles from the crater—Quality of the ashes ejected at that time—Quality and origin of the sand which occupies a considerable part of the island—

Internal construction of the island—Conjectures that the crater of this volcano was anciently at the summit of Stromboli—The island formed of a single, but bifurcated, mountain—Incontrovertible testimonies that, for more than a century, the crater of this volcano has been situated towards the middle of the mountain—Error of Sir William Hamilton in placing this crater at the summit—The opinion, generally admitted, of the intermissions of the conflagration of Stromboli, probably, not well founded—The eruptions at that time much weaker than they frequently are—The declivity of the mountain to the west the only place where the ejected matter falls into the sea—Absurd reason assigned by the inhabitants of the Eolian isles why that part of the sea into which the ejected matter falls is never filled with volcanic substances—Explanation of the author—Description of the road up the mountain towards the crater—Height of Stromboli—Hot acid-sulphureous fumes near the summit, which have an internal communication with the volcano—

cano—Remains of an ancient crater at the summit of Stromboli—Appearance of the ejections seen from above—Their perpendicular height—Conclusive proofs that the volcano of Stromboli is not intermittent, as some travellers have asserted—The cavity of the crater of this volcano probably not very deep—Streams of smoke which issue from three several parts of the volcano—The author succeeds in an attempt to approach nearer to the crater—Phenomena which he observed in consequence of this nearer approach—Form and structure of the crater—Liquid lava within it—Qualities of that lava—The eruptions of Stromboli little, or not at all, intermittent—Observations made by night within the crater itself—An unexpected and terrible phenomenon—Its explanation.

THE island of Stromboli is distant from Sicily fifty miles, and is the first of the Eolian isles to the north-east. It was called Στρογγύλη by the ancient Greeks, from its round figure, and was celebrated for its ex-

traordinary volcano. Etna, Vesuvius, Hecla, and other burning mountains, rage at intervals, and vomit forth torrents of fire, but afterwards relapse into a total inaction which continues several years, and sometimes whole centuries; but the eruptions of Stromboli are continual, though not so continual but that, according to the accounts of all the modern travellers, they have sometimes short periodical intermissions.

I sailed from Naples for Sicily on the 24th of August 1788; and the next night, having proceeded to a considerable distance beyond the straits of Capri, I began to discover the fires of Stromboli, though at the distance of at least a hundred miles. I observed a sudden blaze, which feebly struck my eyes, and after two or three seconds disappeared. After ten or twelve minutes the flame again became visible, and again disappeared. I observed this phenomenon for several hours, and it only differed in its longer or shorter duration, and the intervals between its appearances. The mariners
with

with whom I sailed testified considerable joy at the sight of this fire, as they assured me that, were it not for the light it afforded in dark and stormy nights, they should frequently be in danger of being shipwrecked at sea, or running on shore on the neighbouring coast of Calabria.

When day arrived, and we had approached much nearer the volcanic island, the light of the sun prevented the flame from being visible; but a smoke appeared, which had nearly the same alternations with the fire before observed. As I was now, however, on my way to Messina, with intention to ascend and examine Mount Etna, I soon lost sight of the volcano, which I proposed afterward to visit, on my return from Sicily, when I should take up my residence for a short time in Lipari.

This design I carried into execution on the 1st of October, taking the advantage of a felucca which was returning to Stromboli. We sailed early in the morning, a strong
south-

south-west wind blowing, and some clouds floating in the atmosphere which appeared to threaten a tempest. The sea was rough; but the wind being in our favour, the master of the felucca, who was at the same time our pilot, encouraged us against the fear of any accident, only telling us, in a jocular manner, that *we should have a little dancing*. All the sails were set, and we flew rather than sailed over the surface of the sea. Though the wind continually increased, and the sea ran higher, so that we were sometimes hanging on the pinnacle of a wave, and again plunged to the bottom of a yawning gulf, we had nothing to fear, as the gale was exactly in our stern; and in less than three hours we arrived at Stromboli, which is thirty Italian miles from Lipari, and anchored on the north-east side of the island, where the body of the mountain breaking the force of the wind rendered the sea somewhat more calm.

During a great part of this voyage we were accompanied by a number of fish, which appeared

appeared to attend us as an escort. These were dolphins, which surrounded the ship, playing their gambols, and springing sometimes from the stern to the prow, and back again; then suddenly plunging under the waves, and as suddenly re-appearing, holding up their snouts, and throwing up the water to the height of several feet from the spiracles which they have in the head. On this occasion I observed what I had never noticed before in any of the smaller fish of the cetaceous kind in other seas, I mean the incredible swiftness with which they swim and turn in the water. They would frequently dart from the stern to the stem of the ship, and, though they had to encounter the resistance of the agitated waves, fly with the rapidity of an arrow.

But I return to observations of another kind, and such as are relative to the principal object of this work.

As we advanced towards Stromboli, which was continually before me, I observed that
its

its summit was covered with a very thick smoke, which extended to the brow of the mountain. I landed at nine in the morning; and, eager to gain information relative to the volcano, without delay began to ascend the mountain, till I arrived at the extreme edge of the smoke, which I wished to examine with attention. This smoke, to all appearance, perfectly resembled the clouds. In the lower part it was black and dark, and white and shining in the upper; from the former being penetrated with but little of the solar light, and the latter with a greater quantity. It was so thick that the sun could not be seen through it. The upper part of it separated into a number of globes, and various irregular and unusual forms, which, according to the motion of the air, ascended, descended, or took a circular course, becoming whiter, and more irradiated by the sun the higher they arose; all which appearances are observable in the clouds, especially in the time of summer. This smoke, when it had reached a great height, became so thin as to be no longer discernible

discernible by the eye. The sulphureous acid it contained was extremely manifest, and so inconvenient to respiration, that I was obliged to return to the plain, not being able, at that time, to attempt a nearer approach to the volcano, from which dull and hollow explosions were almost continually heard.

The remainder of the day I employed in interrogating the people of the island relative to their volcano, it appearing to me that no persons could give me more information than those who continually had the mountain before their eyes. The following were the accounts I received from them. When the north, or north-west winds blow, the smoke is little in quantity and white, and the explosions of the volcano very moderate; whereas the latter are louder and more frequent, and the former much more extensive, and black; or at least dark, when the south-west, south-east, or south winds prevail; and should any one of these three winds blow with violence, the smoke will sometimes spread
 6 itself

itself over the whole island, and darken it like heavy clouds in rainy weather. Should this cloud of smoke thus extend itself when the vines of Stromboli are in leaf, if it remains only a few hours, it will not injure them; but should it continue a whole day, or longer, the grapes will not ripen, or at least the vintage will be less productive. The smoke constantly has the odour of burning sulphur, and consequently is very disagreeable and noxious.

This thick and copious smoke, which is commonly accompanied with more violent and frequent eruptions, not only is emitted while the south, south-east, and south-west winds blow, but precedes these winds several days. The people of the country are therefore enabled to foretel the winds which will be propitious or adverse to mariners. They told me that, not unfrequently, vessels which had anchored at Stromboli during the winter, and proposed to sail because the sea appeared calm and the weather favourable, had been induced

to

to remain longer by the observance of these prognostics, which they had not found deceitful. The knowledge of these indications is not, however, the fruit of the modern observations of these islanders: it is extremely ancient*, and has been transmitted from the most remote ages to the present, from generation to generation, and will probably be delivered down in like manner to the latest posterity. Æolus, who is said to have reigned in these islands, is styled in fable the King of the Winds, probably, as some writers have conjectured, because, from the changes in the smoke and eruptions of the volcano, he was able to predict what winds would blow.

I shall here (if I may be allowed a short digression not unsuitable to my subject) relate the observations which I made relative to the connection between the phenomena

* Those who wish to know the predictions of the ancients, relative to the changes in the air and the sea, deduced from the smoke and fires of Stromboli, may consult the *Sicilia Antiqua* of Philip Cluverius.

of the atmosphere and those of the volcano, during the five-and-thirty days which I remained in the Eolian isles; the smoke of Stromboli by day, and the flames by night, being clearly visible in those islands, and the adjacent sea.

Twice within that time, on the 13th of September, and the 1st of October, the *Libeccio*, or south-west wind, blew strong. The first time no sensible change was observable in the volcano of Stromboli, though, according to the assertion of the people of the island, the smoke should have collected thicker round the mountain, and the explosions have become louder. The second time, the appearances approached nearer to those they describe.

The *Scilocco*, or south-east wind, blew three times: on the 21st and 26th of September, and the 7th of October. This wind, if we believe the mariners of Stromboli, has a similar effect on their volcano with the south-west; and, in fact, on two

of

of the above-mentioned days, while this wind blew, the eruptions were stronger, and the cloud of smoke more extensive; but the third time these effects were not observable.

On the contrary, the north wind, which blew on the 11th and 12th of October, and which, according to these islanders, leaves the volcano at rest, was preceded and accompanied by explosions which were heard in the other islands, and by a large cloud of smoke which covered the half of Stromboli, and rose with a white edge, like that we sometimes observe in tempestuous clouds.

I must add, that, sometimes, though not a breath of wind blew, the eruptions were very copious, and the smoke was extremely thick.

These observations render me not much inclined to receive implicitly all that the people of Stromboli so positively assert relative to their volcano; and the less, since

the mariners of the other Eolian isles are of a different opinion. When I was at Felicuda, where the eruptions of Stromboli may be very clearly seen by night, those eruptions were very strong, and almost continual, and every one was followed by an explosion, which might be very distinctly heard in that island. I turned to one of the mariners of Felicuda, who stood near me, and asked him what he thought of the prognostics of that volcano. He returned me the following brief sententious answer: *Stromboli non fa marinaio*, Stromboli will not make a seaman. To determine, however, with certainty, whether there are any direct and immediate relations between the changes of the atmosphere and those of Stromboli, and what those relations are, would require a series of observations for several years, made on the spot by some intelligent and unprejudiced naturalist; and these we certainly have not.

I shall now proceed to relate what I observed

served relative to the volcano on the night of the 1st of October. My residence was in a cottage, on the north side of the island, about half a mile from the sea, and two miles from the volcano; but so situated that the cloud of smoke round the mountain scarcely permitted me to see the top of the fiery ejections. I employed more hours of the night in making my observations, than I permitted myself for repose; and the following is a brief summary of the principal appearances I noticed.

The south-east wind blew strong. The sky, which was clear, the moon not shining, exhibited the appearance of a beautiful aurora borealis over that part of the mountain where the volcano is situated, and which, from time to time, became more red and brilliant, when the ignited stones were thrown to a greater height from the top of the mountain. The fiery showers were then more copious, and the explosions which followed them louder, the strongest resembling those of a large mine which

does not succeed properly, from some cleft or vent. Every explosion, however, slightly shook the house in which I was, and the degree of the shock was proportionate to the loudness of the sound. I do not believe that these shocks were of the nature of the earthquake; they were certainly to be ascribed to the sudden action of the fiery ejections on the air, which struck the small house in which I was, in the same manner as the discharge of a cannon will shake the windows of the neighbouring houses, and sometimes the houses themselves. A proof of this is, that the fiery showers always were seen a few seconds before the shock was felt, whereas the house was so near the volcano, that, had it been a real earthquake, no interval of time would have been perceptible.

Before the morning rose, the fiery light over the volcano increased so much, at three different times, that it illuminated the whole island, and a part of the sea. This light was each time but of short duration, and the

the showers of ignited stones were, while it lasted, more copious than before.

On the morning of the 2d of the same month, the south-east wind blew stronger than ever, and the sea was greatly agitated. The smoke of Stromboli formed a kind of cap round the top of the mountain, which descended much lower than on the preceding day. The phenomena were the same; but the convulsions of the volcano were more violent. The explosions were very frequent, but always with a hollow sound; and the ejected ashes reached the scattered dwellings of the people of the island. In the morning, the ground appeared very plentifully sprinkled with these ashes, as they are called by the natives; but on examination, I found that they were not properly ashes, but very finely triturated scorix, consisting of very small grains, of no determinate form, dry, and rough to the touch, and which crumble into powder under the finger. They are not very far from a vitreous nature, in colour between a grey

and a red, semi-transparent, and so light, that some will float on the water. Their levity proceeds from the great quantity of vesicles, or pores, which they contain, and which causes them, when viewed with the lens, to bear some resemblance to the sea production of unknown origin called favago (*favaggine*).

The islanders assured me that these eruptions were very inconsiderable, compared with others which had formerly taken place, during which the ashes had, in a few hours, formed a covering over the ground and the houses of several inches thick; and the stones thrown out were scattered over the whole island, to the great damage of the vineyards and woods which were near the volcano, to which the flames communicated*.

As

* These showers of sand and pulverized scoriae seem to be inseparable from volcanic eruptions, and to be copious in proportion as the latter are violent. Of this we have an example in the eruption of Etna

in

As the day advanced, the hope I had entertained that I should be able immediately to visit the volcanic fires of Stromboli, greatly diminished; since I must have had to pass a large tract of the mountain entirely covered with smoke, which had extended itself so widely through the air, that it darkened the whole island. I deferred, therefore, my intended journey till the next day, should that prove more favourable, and employed myself in examining the principal productions of the place.

Wherever I placed my foot, I found the whole shore, to the east and north-east, composed of a black volcanic sand. This sand is an aggregate of fragments of shoerls, as has been remarked by M. Dolomieu; but when we view it with the lens, we discover,

in 1787 (see vol. i. chap. vii.) when the sand was carried as far as Malta. How great a space was covered by the sand ejected from Etna, in the eruption of 1669, has been already noticed. There is likewise no eruption of Vesuvius which is not accompanied by similar showers of sand and ashes.

besides the shoerls, which are entirely opaque, and are attracted by the magnet, a number of small transparent and vitreous bodies, of a yellowish green tincture, and which are insensible to the magnet. I was doubtful whether these were likewise fragments of shoerls, but of a different species, or whether they were volcanic chrysolites; their extreme minuteness not permitting me to ascertain their nature by any satisfactory experiment.

This sand extends into the sea, to the distance of more than a mile from the shore; as appeared from its adhering to the sunken plummet, when it had been previously covered with tallow: probably it reaches to a still greater distance.

The sea easily penetrates through this sand; for if any part of the shore be dug into a little depth, sea water is found, but rendered somewhat more fresh by having left a part of its salts in the sand; as happens to the same water when it issues, drop by drop, through a long tube filled with sand, through
which

which it is filtred. The fishermen of Stromboli, when they are in want of fresh water, frequently dig wells on the shore, and drink the water these afford.

This sand, as has been already said, occupies that part of the island which fronts the east, and the north-east, extending on the one side to the sea, into which it stretches, and on the other to the summit of the mountain. It owes its origin partly to the immediate ejections of it by the volcano, and partly to the pieces of scoriaceous lava thrown out by the same, which being, as has been said, extremely friable, and greatly abounding in shorls, easily decompose and become pulverized in this sandy matter. In fact, nothing is more usual than to find in it fragments of this scoriaceous lava, of various sizes. This sand is found principally near the volcano, where both it, and the scoriaceous lavas from which it is formed, fall in the greatest quantities; but as, from its fineness, it is easily moveable, it is

5

carried

carried by the wind to the vallies and lower grounds quite to the sea,

This, however, is only the thin upper coating of those parts of Stromboli which it covers, as under it lies the firm texture of the island; I mean the solid lavas, which are visible on several steep descents, that have been stripped of the sand, either by the action of the rain-water, or that of the winds.

On the same day I made the circuit of a great part of the base of the island, which is about nine miles in circumference, and found the same solid constructure; a small tract of tufa, on the north side, excepted, which descends to the sea,

In this excursion, I carefully examined the course and direction of the lavas, and was convinced that they all had flowed from the steepest summit of the mountain, under different angles of inclination, passing one
over

over another, and thus forming a succession of crusts, or strata, like, in some measure, the coatings of which an onion consists, In several places where the lava has entered the sea, these crusts may be seen lying one over the other, some of them broken or separated by the shock of the waves.

These facts strongly induced me to suspect that the crater of Stromboli had anciently been situated on the summit of the mountain, and that the lavas which had principally contributed to the production of the island had flowed from that crater.

On the sides of Etna and Vesuvius, mountains of an inferior order arise, which likewise owe their origin to fire: Stromboli, on the contrary, is entirely a single mountain, except that its top is divided into two summits. Hence it appears that there have been none of those eruptions in its sides, which generate lesser mountains, or hills, of a conical form.

But

But this crater, which I conjecture, and shall hereafter prove, actually to have existed, has long since given place to that which, at present burns. Among the various enquiries which I made of the inhabitants of Stromboli, I interrogated them with respect to the precise situation, in former times, as far as they had heard or could remember, of that burning gulph which throws out fire and red-hot stones; and they all agreed in assuring me that they had never known it in any other place but that in which it now is, that is to say, about half way up the mountain.

I lodged with a priest who was now approaching the decline of life, who not only confirmed this account, but adduced the authority of his father, who had died at the age of eighty, and who had told him that he had heard, from persons older than himself, that in their time the situation of the burning furnace was the same as at present.

About

About a mile from the mouth of the volcano, lives a peasant, who from his cottage can distinctly see every burning eruption; and though he frequently feels no little alarm, when the fragments of lava are thrown quite to his doors, and the fire reaches his little vineyard, yet, from long habit, and love for the place of his birth, he still continues to reside there. When I asked this man what was the situation of the burning cavern in former times, he returned me the same answer I had received before; alleging, in confirmation of its truth, the testimony of his ancestors who had resided on the same spot. And as to the showers of ejected matter, all of whom I enquired unanimously assured me that they had always seen them such as they at present appear, except that they might be sometimes stronger and sometimes weaker.

All these testimonies appear sufficiently to prove that the volcano of Stromboli has burned for more than a century where it
now

now burns, without any sensible change having taken place in its situation.

I shall here make a few remarks on the account which Sir William Hamilton has given us of Stromboli, agreeably to my promise in the introduction to this volume.

He tells us, that on his return from Messina to Naples he met with a calm, while among the Lipari islands, which lasted three days. "Hence," says he, "I had an opportunity clearly to ascertain that all these islands have been formed by eruptions. That which is called Volcano, is in the same state in which Solfatara now is. Stromboli is a volcano which has preserved its vigour entire, and consequently a form more pyramidal than the rest of the islands. We frequently saw burning stones thrown from its crater, and lava issuing from the sides of the mountain, flow down into the sea."

This

"This description is accompanied by a plate which is the thirty-seventh plate of the *Campi Phlegræi*, and represents the mountain of Stromboli. In it the crater is represented at the summit, throwing out flames and ignited stones; and on the sides are seen streams of liquid lava descending into the sea. That the observations of this respectable naturalist on volcanos merit the most attentive consideration, the work I have cited furnishes numerous and incontestable proofs: that impartiality, however, which ought to be inseparable from philosophy, compels me to declare that what he has said of this mountain is not exactly consonant to fact. From the time of his observations to that of mine, only twenty years have elapsed. If, therefore, the crater of Stromboli had, then, been at the summit of the mountain, and had it thrown out thence its showers of fiery matter, the inhabitants of the island would surely have remembered the fact when I was there: but when I told them that, twenty years before, the burning gulph of their mountain was not situated
half

half way up its side, but at the top; they all positively asserted that this must be a mistake.

The same they affirmed of the assertion that lava had issued from the sides of the mountain, and flowed down into the sea; when, to hear their answer, I told them that this had been observed at the same time. Indeed, it seems very extraordinary, that I should never have met with any traces of these currents of lava, though I so carefully examined the island.

I am of opinion, that Sir William fell into these errors from not having landed at Stromboli, but only viewed it at sea, at a distance, where he might easily be deceived by some illusion of sight. In fact, had he landed, it is not to be doubted, but he would have mentioned it. That he made his observations at some distance from the island, is sufficiently indicated by these words: "Stromboli is a volcano which has preserved a form more pyramidal than
" the

"the rest of the islands." When Stromboli is seen at a distance it certainly appears of this pyramidal, or, more properly, conical form, much more than when seen near; for then it appears bifurcated, nearly similar to Montè Rosso, on one of the sides of Mount Etna.

The distance has likewise rendered him inaccurate relative to the island of Volcano. Had he landed there, and examined the place, he would not have compared it to Solfatara. We shall see in Chap. XIV. of this Work, the difference of the states of the two volcanos.

The figure, more or less conical, of the Eolian isles, as seen from the sea, while Sir William sailed among them, the smoke which he saw rise from some, and the fiery eruptions of others, suggested to him, I imagine, the idea that "they have all been formed by eruptions;" as he has not adduced a single local fact in support of that opinion.

On the 2d of October I made the observations I have already related, at the foot, and the lower part of the sides of Stromboli. The following night the volcano exhibited phenomena similar to those of the preceding, and the next day (the 3d) proved favourable to my wishes to approach nearer to the burning crater. It now smoked but little, and only a few explosions, and those scarcely audible, were heard. The sky was free from clouds, and the sea calm.

The crater may be approached by two several ways; either by taking a boat, and observing it from the sea; or by land, passing the top of the mountain, and proceeding as near as possible to the edges of the crater. I resolved to observe it, first, from the water, taking advantage of the calm which then prevailed; as I well knew how frequently that sea is violently agitated by tempestuous winds.

After having coasted the island the distance of three miles and a half towards the north,

north, I arrived opposite the place where the showers of ignited matter fall into the sea. The side of the mountain is here a steep declivity, almost perpendicular, about half a mile broad at the bottom, and a full mile long, terminating above in a point, and forming an isosceles triangle, the base of which is washed by the sea. The apex of the triangle is at the brink of the crater. Before I reached the steep declivity, I observed a great cloud of dust extending along it, of which I could not assign the origin; but on a nearer approach I discovered the secret. It was evidently produced by pieces of lava, of various sizes, which rolled down, and, in their descent, raised the fine sand with which this declivity is covered.

While I was intently observing this object, the mountain suddenly made an explosion. A quantity of pieces of lava, of a dark-red colour, enveloped in smoke, were ejected from the top of the precipice, and thrown high into the air. A part of them

fell again upon the declivity, and rolled headlong down, the smaller preceded by the greater, which, after a few long bounds, dashed into the sea, and, on entering the waves, gave that sharp hissing sound which, in a lesser degree, is produced by a bar of red-hot iron which a smith plunges in the water. The lesser fragments of lava followed, but, from their lightness and the hindrance of the sand, rolled slowly down the declivity, which was then obscured by a small cloud of dust; and striking against each other produced nearly the same sound as is occasioned by large hailstones falling on the roofs of houses. In a few moments after, another explosion followed; but this was a small one, without any sensible noise, and the few pieces of lava that were thrown up, rose to but a small height, and fell back into the crater. Two minutes after, a third eruption took place, with a much louder explosion than the first, and a far more copious ejection of lava. The eruptions which I afterwards observed, and which

were

were innumerable in the space of three hours, that I continued there, exhibited the same appearances.

These observations caused me to doubt of the truth of an opinion to which I had inclined before my arrival in the island. I mean the periodical intermissions which travellers ascribe to the eruptions of Stromboli ; and which I supposed I had observed, in the night, in my voyage from Naples to Sicily. When from the bottom of this precipice I had the volcano and its fiery hail before my eyes, I do not, indeed, mean to affirm that it continually raged and thundered equally ; but the intermissions between its ejections were so short that they rarely exceeded three minutes, though by the accounts of these travellers they are considerably longer. Yet was I willing still to suspend my judgment, until I should have had a nearer view of the crater, on the mountain itself.

The following night I returned to the

same place, persuaded that I should see new objects to excite my admiration; and in fact, the scene I beheld, appeared to me as delightful and astonishing, as it was noble and majestic. The volcano raged with more violent eruptions, and rapidly hurled to a great height thousands of red-hot stones, forming diverging rays in the air. Those which fell upon the precipice, and rolled down it, produced a hail of streaming fire, which illuminated and embellished the steep descent, and diffused itself around through a considerable space.

But, independent of these ignited stones, I remarked a vivid light in the air, which hovered over the volcano, and was not diminished when that was at rest. It was not properly flame, but real light reverberated by the atmosphere, impregnated by extraneous particles, and especially by the ascending smoke. Besides varying in its intensity, it appeared constantly in motion, ascended, descended, dilated, and contracted, but constantly continued fixed to one place,

place, that is, over the mouth of the volcano; and clearly shewed that it was caused by the conflagration within the crater.

The detonations, in the greater eruptions, resembled the distant roar of thunder; in the more moderate the explosion of a mine; and, in the least, they were scarcely audible. Every detonation was some seconds later than the ejection. This, likewise, was observable by day.

I remained that night two hours on the water at this place, and the eruptions were so frequent, and with such short intermissions that they might be said to be continual.

During both these visits, thick showers of sand and fine scoriæ fell into the sea, and falling on my hat, which was of oil-cloth, made a noise like a small hail.

The five sailors who had the care of the boat in which I was, and some other natives of Stromboli who were with me, and whose

occupation frequently brought them to that part of the sea, told me that the volcano might now be considered as very quiet; assuring me, that, in its greater fits of fury, red-hot stones were frequently thrown to the distance of a mile from the shore, and that, consequently, at such times, it was impossible to remain with a boat so near the mountain as we then were. Their assertion appeared to me sufficiently proved by a comparison of the size of the fragments thrown out in the explosions I now witnessed, with that of those which had been ejected in several former eruptions. The first (many of which had been stopped at the bottom of the precipice by other pieces of lava, and were scoriaceous lavas, approaching to a globose form) were not more than three feet in diameter; but many of the fragments thrown out at other times, of similar quality to them, and which lay in large heaps on the shore, were some four some five feet in diameter, and others even still larger.

Travellers

Travellers have generally asserted that the volcano of Stromboli has for a long time discharged its fury into the sea, without causing either alarm or injury to the inhabitants of the island. The eruptions, however, fall equally on every side around the volcano; though at this place they only fall into the sea, and in that sense their assertion is well-founded.

But the people of Stromboli, and indeed almost all the inhabitants of the Eolian islands, entertain an opinion, equally amusing and paradoxical, by which they explain why that part of the sea which is contiguous to the precipice is never filled up, notwithstanding the immense quantities of stones which have been continually falling into it from time immemorial; where, instead of a peninsula having been formed by those stones, as might naturally have been expected, the sea is generally said to have no bottom. To explain this apparent paradox, these good folks affirm, with the most entire conviction that what they say is true,
that

that the stones of the volcano which fall into the sea are attracted again by the mountain through secret passages ; so that there is a constant circulation from the volcano to the sea, and the sea to the volcano.

I did not attempt to controvert their favourite hypothesis, which would have been to no advantage, and to no avail ; but I caused that part of the sea to be sounded, and found it a hundred and twenty-four feet deep, which, though that is not a great depth in the Mediterranean, is certainly, in this place, somewhat surprising ; as it was rather to be expected that the continual discharge of stones into it should have produced a little hill, which would at last have emerged above the waves.

Thinking this an object deserving some enquiry, I determined to make my observations on the spot, and I flatter myself I have discovered the true explanation of the difficulty. The stones which have formerly been thrown into the sea by Stromboli, and those

those which that volcano still continues to eject, are of the same kind ; that is, as I have already said, scoriaceous lava. These, from their being porous and little cohering in their internal structure, easily crumble, and are converted into sand, as is seen on the east and north-east parts of the islands; and this separation of parts is produced by the simple action of the elements of air and water, and the rolling of the pieces over each other in their descent. A similar trituration is effected at the place where the lava falls into the sea. The steep descent I have so frequently mentioned is covered with this pulverized lava quite to the sea shore. A part, therefore, of the scorix is already reduced to powder before it touches the water ; and the remainder, which falls into the sea in whole pieces, must soon undergo the same trituration, from the action of the waves which beat so violently in various directions.

I must here repeat that the sea which surrounds the islands of Lipari, and especially that part of it which washes Stromboli, is
subject

subject to very frequent and very violent storms. The two times that I observed the volcano from the sea, near the precipice, though it was what the sailors called a perfect calm, our boat was so tossed that it was necessary to make use of the oars to prevent its being carried from the place. This agitation of the water, likewise, extends, here, to a considerable depth; as is sufficiently proved by several observations. The inhabitants of Stromboli, besides nets, make use of weels, or a kind of wicker traps, to catch fish. Into these they put stones, and sink them to the bottom, leaving a sort of floating buoy to point out where they lie; but to prevent their being carried away by the waves, in a storm, it is necessary that they should be sunk to the depth of a hundred and forty feet; otherwise they would be dashed against the rocks under the water, and lost. As the depth, therefore, of that part of the sea into which the scorixæ fall is less than this, that is, only a hundred and twenty-four feet, they must, by the shocks of the tempestuous waves, no doubt, be soon

soon broken, reduced to sand, and carried away by the violence of the current. It is not, therefore, so extraordinary, as it may at first view appear, that this part of the sea should be scarcely ever filled by the scoriaceous lava which is continually falling into it.

I have said, *scarcely ever*, because I was told, by some of the people of Stromboli, that about forty-four years ago the volcano threw out such an immense quantity of scorix, that it caused a dry place, to use their expression, in the sea. A kind of hill rose above the waters, which remained from March to the following July, when it gradually diminished, by the action of the waves, and at last disappeared. The hill was formed precisely in that place where, according to the popular report, the sea has no bottom. This fact not only is agreeable to the hypothesis I have offered, but is a strong confirmation of its truth.

The observations I had been able to make

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on the volcano from the sea appeared to me interesting and instructive; but I flattered myself that more of its secrets would be revealed to me, if I made a nearer visit to it, over the mountain itself. The way thither lay on the east side of the island, it being impossible to approach it from the sea, both from the incessant showers of heated stones, and the insuperable precipices on both sides of the steep and almost perpendicular declivity. I began this journey on the 4th of October, and was much encouraged by the state of the volcano, to hope I should succeed according to my wishes, as scarcely a shade of smoke covered the highest points of the island. To arrive there it was necessary to make a journey of a mile and a half, reckoning from the sea-shore. The first mile is not disagreeable, but the remainder of the way, though not dangerous, is very difficult; both from the extreme steepness of the ascent, from the impediment of the sand, in which the leg sinks almost up to the knee at every step, and from the loose and moveable scorix, which render the

summit of the mountain extremely rugged and slippery.

Having reached this summit, I found myself on one of the two points which render Stromboli bifurcated, though, when viewed at a distance, it appears conical. This summit is situated to the north-east: the other, which is somewhat higher, inclines to the south-west. As nearly as I could estimate it, the altitude of the latter above the sea was about a mile.

To pass from one summit to the other, we go over an extensive plain, which appeared to me to deserve the most attentive examination. We first observe white fumes, which arise from five apertures, not very distant from each other. These fumes have a strong sulphureous odour, and, gliding along the ground, are insufferable from their extreme heat. The five apertures appear sprinkled over with small crystals of sulphur, and muriate of ammoniac (sal-ammoniac). The ground here is a mixture of sand and scorix;

scoriae; and the sand, as well below as on the surface, is moist, which may arise from two causes, either from the subterraneous waters being raised in vapour by the volcanic fire, as water constantly accompanies burning volcanos; or from the union of the acid of sulphur with the humidity of the atmosphere.

The ground in the vicinity of these fumes is very hot; and wherever a hole is made with a stick, a new stream of smoke arises; which is not fugitive but durable. If you stamp with the foot, a feeble kind of echoing sound is heard, which I do not imagine to be occasioned by any subjacent gulf or abyss, but only from the very loose texture of the ground, which is only composed of sand and very porous scoriae; in the same manner as in several parts of the Apennines, where the ground is light and loose, I have heard the same kind of sound on stamping with the foot. I am, therefore, of opinion, that this hot fuming ground has a communication with the volcano, by nar-

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row winding cavities which afford a passage to the vapours.

Proceeding to the west, over the plain which extends between the two summits, another object arrests still more the attention of the observer. The summits themselves have no crater, nor any vestiges of one; but these vestiges are sufficiently evident on the sides of the plain; which here sinks into a cavity, which may be about three hundred feet in length, from east to west, above two hundred in breadth, and one hundred and sixty in depth. The bottom is covered with sand and scorix, not of a very ancient date, but the produce of the ejections of the present volcano. The internal sides of the cavity, however, are not of these materials; they are formed of stratas of lava which bear the most evident marks of the highest antiquity. I am, therefore, of opinion that this was the first and largest volcano of Stromboli, which formed the contexture of the island by its lavas, and which, in a great degree, had

been filled up and destroyed by the earthy depositions of the rain-waters, the matter ejected into it by the present volcano, and, perhaps, by the falling in of its own sides. This opinion is confirmed by the direction of the lavas, all of which appear to have descended from the centre of the summit; and this direction, when I examined the lower parts of the island, induced me to conjecture that the principal volcano had formerly existed on the summit.

These remains of an ancient crater lie between two points of the mountain which were probably formed when the lava gushed forth, in the same manner as the volcano of Monte Rosso formed two distinct hills. The bottom of this higher and more ancient crater of Stromboli, in two places, emits fumes, which do not differ in their quality from those that have been mentioned above.

From these two summits the ejections of the present crater are distinctly observable;

as it is not distant more than half a mile to the north; and we there evidently perceive that it lies about half way up the mountain, the edges obscurely projecting, and forming a cliff. Here I was better able, than on the sea, to estimate, by the eye, the height to which the ejected matter ascends; and can affirm that, in the more violent eruptions, it rises to the height of half a mile, or even higher, as many of the ignited stones were thrown above the highest summit of the mountain. They did not, however, reach me, but fell, partly on the precipice which descends to the sea, and partly into, and around, the crater. The ejections, indeed, which I call the most violent, were, certainly, very moderate, compared with those which the two natives of Stromboli who served me as guides, assured me they had witnessed, at other times, from that summit, when, as they said, we should not have been safe at the distance and height at which we were; and the numerous scorix around us, the produce of former eruptions, fully confirmed the truth of what

they asserted. They likewise deserved attention when they affirmed that, at those times, the stones were thrown to more than a mile in height.

From the summit of Stromboli I descended about a quarter of a mile down the mountain towards the volcano, and took my station on an eminence where I had a much more distinct view of the crater, and every eruption; and was more than ever convinced that the intermissions which have been so frequently and positively ascribed to it do not exist. The explosions succeeded each other with such rapidity, that there was rarely the interval of three or four minutes between any two. They, however, differed greatly in their strength, which has probably occasioned the mistake of travellers relative to the intermissions of Stromboli. The highest ejections, as I have already said, did not rise less than half a mile in height; while the lowest did not reach the height of fifty feet, and the matter fell back into the crater. Between the
greatest

greatest and the least, there were ejections without number; and the intensity of the sound corresponded to the quality of the ejection. At a considerable distance from the volcano the moderate and smaller eruptions, with their accompanying detonations, were not perceptible, but the greater only; which, not being so frequent, may easily induce us to form the false opinion that this burning mountain has considerable intervals of repose. But when we approach nearer, we distinctly perceive the difference of the ejections, and the error of such a supposition. Nor can the fact I observed be considered as accidental, since the two guides I took with me, who are accustomed to conduct strangers to this place, as well as other natives of Stromboli, who frequently pass that way to cut wood, all agreed that the eruptions of this volcano are continual, though they are sometimes stronger and sometimes weaker.

At a distance, there was a very perceptible interval between the appearance of the

eruption and the detonation ; but here, the difference of time between them was scarcely any. The fragments of lava, as they flew, produced a hissing sound ; and many of them acquired in the air a globose figure, an evident proof of their fluidity ; but before they came to the ground, they were hardened, retaining the same figure, while they bounded down the cliffs and precipice. From the little eminence on which I stood, I could, in part, discover the internal sides of the crater, though I could not see far into it ; but appearances seemed to indicate that it could not be very deep ; for, attentively observing the fragments of lava that fell again immediately into the crater, I remarked, that almost as soon as they had entered it I heard the sound produced by their collision against the substance on which they fell. This sound resembled that which would be caused should water, or rather some denser fluid, be struck with a number of staves or poles. But of this phenomenon, and others more deserving notice, I shall treat, presently, more

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at length, when I come to speak of other secrets of the volcano which were disclosed by a nearer approach.

Here it is proper to notice the fumes which exhale from this mountain, as they have an immediate relation to the volcano. Though when I observed them from the sea, they appeared to me of little importance, when I saw them from the summit and body of the mountain they exhibited a thick cloud, several miles in length, exhaling a strong smell of sulphur, which, however, was not incommodious to me, as they were raised several poles above the surface of the ground. This cloud entirely obscured the sun, was black in the middle, but whitish at the edges, and more or less clear according to the different inclinations, refrangencies, and reflections of the light. It appeared to me that this immense mass of smoke extended more than a mile in height. Though it continually issued in a considerable quantity, its volume did not increase, since as much was dissipated in the upper regions of the air, as rose

from the earth. It derived its origin from a threefold source. First, as often as the crater threw up stones, a cloud of grey smoke immediately arose, which was thick in proportion as the ejection was violent and copious. Secondly, to the west of the crater, and at a little distance from it, are some obscure apertures, through which arise, like white clouds, not less than a hundred and fifty streams of smoke, which, though they are distinct at first, mingle as they rise, and form one cloud.

Lastly, to the east of the crater, there is a large and deep cavern from which ascends a column of dark and very thick smoke, about twelve feet in diameter, which, at that time, from the stillness of the air, arose perpendicularly, moving in large circles through a considerable space, and afterwards insensibly rarefying as it removed to a distance. This cavern, while I was there, threw out no stones, nor had it ever been known to do so, as my guides assured me, though it had always emitted a prodigious quantity of smoke.

smoke. The causes, therefore, of this smoky cloud were these three, of which the first and third are continual, and the second acts as often as the crater ejects its burning matter : nor can there be any doubt that they are all three connected with the volcanic gulph ; which makes its greatest discharge from the mouth of the crater, and a much smaller from each of the sides.

Not satisfied with the observations I had already made, my curiosity impelled me to attempt further discoveries. From the pointed rock on which I stood, I could only see the edges of the inside of the crater. I considered, therefore, whether it might not be possible to obtain a sight of the lower parts likewise ; and, looking round me, I perceived a small cavern, hollowed in the rock, very near the gulph of the volcano, into which the rock above prevented the entrance of any burning stones, should they be thrown so far. It was likewise so elevated, that from it the crater was open to my view. I therefore hastened to take my station in
this

this cavity, taking advantage of one of the very short intervals between the eruptions. To my great satisfaction, my expectations were completely fulfilled; I could here look down into the very bowels of the volcano, and Truth and Nature stood, as it were, unveiled before me. The following is the description of the objects which presented themselves to my wondering eyes.

The edges of the crater, which is of a circular form, and not more than three hundred and forty feet in circumference, are composed of a confused mixture of lavas, scoriæ, and sand. The internal sides contract as they descend, and assume the shape of a truncated inverted cone. These sides, from the east to the south, have only a gentle declivity, but in the other parts, they are very steep. In many places, they appeared incrustated over with yellow substances, which I imagine to be the muriate of ammoniac (sal ammoniac) or sulphur.

The crater, to a certain height, is filled with
a liquid

a liquid red-hot matter, resembling melted brass, and which is the fluid lava. This lava appeared to be agitated by two distinct motions; the one intestine, whirling, and tumultuous; and the other, that by which it is impelled upwards. This motion in particular merited to be examined with attention. The liquid matter is raised, sometimes with more and sometimes with less rapidity, within the crater, and when it has reached the distance of twenty-five or thirty feet, from the upper edge, a sound is heard not unlike a very short clap of thunder; while, at the same moment, a portion of the lava, separated into a thousand pieces, is thrown up, with indescribable swiftness, accompanied with a copious eruption of smoke, ashes, and sand. A few moments before the report, the superficies of the lava is inflated, and covered with large bubbles; some of which are several feet in diameter, which bubbles presently burst, and, at the same instant, the detonation and fiery shower take place. After the explosion, the lava within the crater sinks, but soon again rises as before,

- fore, and new tumours appear, which again burst, and produce new explosions. When the lava sinks, it produces little or no sound; but when it rises, and especially when it begins to be inflated with bubbles, it is accompanied with a sound, similar, in proportion to the difference of magnitude, to that of a liquor boiling vehemently in a caldron.

I remained in this cavity, which so conveniently sheltered me from danger, an hour and a quarter; during which time, besides the observations I have already stated, I was enabled to make the following:

Every ejection, however small, was not only accompanied by an explosion, but was proportionate to it in its intensity. Hence, as the stones which are only thrown to the height of ten or twenty yards above the crater, are not visible to the eye at a distance, so, neither, is the detonation by which such ejections are accompanied, sensible to the ear.

In the smaller and moderate ejections, the
stones

stones fell back into the crater, and, at their collision with the fluid lava, produced, as I have already said, a sound similar to that of water struck by a number of staves; but in the greater ejections, a considerable quantity of them always fell without the mouth; though that lying low, and surrounded with heights, the greater part of them rolled again into it. Here, however, we must except that side of the crater which lies immediately over the precipice before described, since there, every stone which fell without the crater, bounded down the declivity, and descended to the sea. When I viewed this precipice from the water, it appeared to me to terminate in a point; but here I distinctly perceived, that, where it reached the volcano, it was more than sixty feet in breadth.

The redness of the larger ignited stones (which were only pieces of scoriaceous lava) was visible in the air, notwithstanding the light of the sun. Many of them clashed against each other and were broken, which happened only when they were at a certain height;

height ; for, when they were nearer to the volcano, they frequently adhered, on touching each other, in consequence of the fluidity they retained. The lava of the crater, when it rose or fell, emitted but little smoke ; but a great quantity when it exploded. The smoke issued from its fissures, but almost immediately disappeared after the explosion. It might be compared to the smoke produced by the firing of gunpowder, and which appears and disappears with the flash. This smoke appeared to me extraneous to the lava ; at least, the fragments of the latter neither smoke as they fly in the air, nor after they have reached the ground.

In consequence of the alternate rising and sinking of the lava, according as it is inflated or makes its discharge, the depth of the crater cannot be considered as constant. When the lava is at its height, it may be about five-and-twenty or thirty feet deep, and when it has subsided, about forty or fifty ; the greatest rising of the lava may, therefore, be estimated at about twenty feet.

If

If we attentively examine the edges of the crater, we can discover no signs that the lava has ever overflowed the brink, much less that it has poured a torrent down the steep side of the mountain.

Though the ejections of the larger and heavier stones have short intermissions, those of the lesser and lighter have scarcely any. Did not the eye perceive how these showers of stones originate, it would be supposed that they fell from the sky: the noise of the more violent eruptions, resembling that of thunder, and the darkness occasioned by the mounting cloud of smoke, present the image of a tempest.

Such were the phenomena of the volcano of Stromboli, which I observed with the utmost convenience from the station I have described. Though it is impossible perfectly to pourtray such astonishing scenes by any drawing, the representation I have given in Plate III. of a part of Stromboli, may enable

ble the reader to form a more adequate idea of the principal objects.

In this plate, A A A represents the vast column of smoke which, to the east of the mountain, issues from a deep and spacious cavern, moving directly upward. B B B, the numerous streams of smoke arising on the opposite side, above which I am myself represented, standing in the cavity of the rock which I have described, and looking down on the showers of fiery matter ejected from the mouth of the crater, which has an opening in front to afford a view of the internal parts of the crater and the fiery ejections. A part of the latter are represented as falling at the top of the precipice which joins to the edges of the volcano, down which they bound, and precipitate into the sea.

To the appearances already described, which I observed by day, I shall add others that presented themselves by night; the cavity in the rock, which I have before mentioned,

tioned, affording me the convenience to make my observations, likewise at that time, in perfect security.

The surface of the burning lava, within the crater, never emitted any sensible flame, not even when the bubbles upon it burst with an explosion; but it shone with a glowing vivid light, and resembled, in its appearance, melted glass in a furnace. From this surface the light diffused itself around, and shot upwards, but with irregularity, sometimes rising and sometimes falling, according, as it appeared to me, the lava itself rose or sunk.

This light in the air became more vivid at every ejection of ignited stones; and was likewise increased in intensity by the quantity of sparks that accompanied each ejection, which were produced, in part, from the breaking of a number of the stones, in their clashing against each other.

Such was the appearance of the volcano
VOL. II. F during

during the night ; but while I was observing it, in my secure recess, and contemplating the astonishing spectacle, an unexpected phenomenon excited in me much more alarm than pleasure. The eruptions of the volcano suddenly ceased, the boiling lava sank lower than usual, without again rising, and lost its vivid glowing redness ; while at the same time the numerous streams of smoke, to the west of the volcano, which before rose in silence, began to issue with a loud hissing sound, and the apertures from which they exhaled to shine with a bright colour of fire. I know nothing to which the sound produced by the issuing of these fumes can be more properly compared than the blowing of large bellows into a furnace by which metals are melted ; such as I have seen at Zalatna in Transylvania, and Schemnitz, and Kremnitz, in Hungary ; except that these volcanic bellows roared a hundred times louder, and almost deafened the ear.

The unexpected change within the crater, and my nearness to those fumes, which,

as they abounded with highly noxious sulphureous vapours, I feared might have mischievous effects, alarmed me so much, that I was on the point of abandoning a place which appeared so dangerous, and seeking safety in flight; had not the guides encouraged me to stay, assuring me, from their repeated experience, that my fears were groundless. "The burning matter which boils within the cavern," said one of them, "always contains a great quantity of air. This air has at present left the fire, and passed through subterraneous passages to those apertures from which the smoke issues, and which we call *respiri* (vent-holes) because there the air from the fire finds vent. But there is nothing to fear: the noise of these vent-holes will soon cease, and the crater boil and throw out burning matter as before."

My companion gave me this account in such a manner as shewed he had himself no idea of danger, and the event happened precisely as he had foretold. In a very short

time the fumes and the volcano returned to their former state. My two guides afterwards assured me that this appearance very rarely happened, and when it did was never of long duration. From this discourse, and other conversation which I had with them afterwards, I perceived that these two natives of Stromboli were better acquainted than any other person with the secrets of their volcano, and the explanation they had given me of the phenomenon I had witnessed, appeared to me extremely judicious.

I think it cannot be doubted that the bubbles which arise in the liquid lava, and burst with an explosion, are generated by an elastic fluid there collected and confined, which being dilated by the strong action of the fire, and incapable easily to disengage itself from the tenacious lava, violently bursts it, and rushes above the crater, producing at the same time a detonation. Hence originate the showers of ejected matter, which are more or less copious, and rise to a greater or less height, in proportion to the greater

or less quantity and strength of this fluid ; which escaping, at every explosion, from the upper parts of the lava, these sink, and again rise when they have received a fresh supply. Supposing, then, the source of the fluid confined, from time to time, within the liquid lava, to be inexhaustible, we shall easily perceive that the eruptions must be incessant. If from the extreme tenacity of the lava, its want of sufficient fluidity, or any other unknown cause, it should be unable to burst it, and open itself a passage within the crater, it will make its way through the subterraneous channels to those apertures from which the fumes ascend, through which it will issue, with considerable noise, till the obstacle it met with in the lava be removed. In such a case the lava will sink without again rising during this interval, and will lose its fiery redness from being no longer urged by the energy of the elastic fluid ; while, from the contrary reason, the apertures from which the fumes issue will acquire a glowing redness, because the fluid escapes through them with violence.

Such were the ideas which floated in my mind, when, the night being considerably advanced, I returned home, with my imagination strongly impressed with the objects I had seen. These ideas I afterwards, in a cooler moment, recalled to a rigorous examination, enquiring, especially, what might be the nature of volcanic gases, not only of such as are imprisoned in the liquid lavas of Stromboli, but of those which are inseparable from other burning volcanos; as likewise in what manner they act, to produce the ejections; objects which appear to me to be at once new and highly interesting. These enquiries produced a number of observations and connected experiments, which it will be more proper to present the reader in another part of the work than in this place; both because they regard volcanos in general, and because to detail and explain them would lead me too far from my present subject, which is to speak of the objects I observed in this volcanic country. As I have, therefore, given some account of the nature and conformation of

Stromboli,

Stromboli, and the most remarkable phenomena of its volcano, I shall proceed to describe, in the following chapter, the different substances of which this island is composed.

C. H. A. P. XI.

STROMBOLI, CONTINUED.

The component substances of this island are scoriæ, lavas, tufas, pumices, and specular iron—Three kinds of scoriæ—The first kind has some degree of vitrification—Stromboli produces no true vitrifications or enamels—The name of pumice not suitable to this kind of scoria—Its ejection, and the figure which it sometimes takes in the air—Second kind of scoria, for which Stromboli is remarkable—Its decomposition where the acid-sulphureous vapours prevail—The substances thrown out of Stromboli more acted on by the fire, than those ejected by other volcanos—The activity of the fires of Stromboli has long remained the same—False opinion of some, that volcanic glasses derive their origin from re-melted lavas—Third kind of scoria—All these three kinds of scoriæ originally porphyry with

with a horn-stone base—Enumeration of the different lavas of Stromboli—Its tufas and pumices—Specular iron—Dangerous situation in which the latter is found—Its crystallization, beauty and variety—Flakes of sulphate of lime (selenite or gypsum) incrust some of these crystallizations, which consist of very thin leaves of iron fastened on each other—Hardness, and, at the same time, fragility of this iron—Changes produced in it, when exposed to the fire of the furnace, and that excited by oxygenous gas (dephlogisticated air)—Decomposed lava the matrix of this specular-iron—Cause of this decomposition—Comparison between this specular iron discovered by the author, and that noticed by others in volcanic matters.—This specular iron produced in the dry way—Rareness of it in volcanic countries—Sulphureous acids produce no change in the iron of Stromboli—Its antiquity—The island of Stromboli formed by rocks of porphyry, melted by subterranean conflagrations, and thrown up by the sea—Different porphyries of countries not volcanic exposed

to the fire of the furnace, to compare the changes caused in them by that with those produced by the volcanic fire—The epoch of the first conflagrations of Stromboli anterior to all history—Few notices left of them by the ancients—Strabo's accounts of Stromboli and Volcano—The eruptions of the latter mountain must have been more frequent and stronger, in the time of that geographer, than at present—Wind, which, according to Diodorus Siculus, blew from these two islands—Mistake of Cluverius, that, in his time, the crater of Stromboli was at the summit of the mountain—The most ancient epoch of the conflagration of Stromboli, known to us from history, anterior to the Christian era by about 290 years—Enquiries relative to the matters which have so long maintained this conflagration.

THE substances of which this island is formed, at least so far as I have been able to discover, are scorix, lavas, pumices, and specular iron ; as likewise the sand of which I have sufficiently spoken in the preceding chapter.

chapter. Of the scoriæ there are three kinds. The first is extremely light, of a dark grey colour, and on it the violence of the fire has taken most effect. Some small pieces are coated over with a true varnish of glass; the others, in general, consist of semi-transparent vitreous threads, some of which are as fine as the threads of a spider's web. We may, therefore, conclude that the matter was in a state of semi-vitrification, when its parts were separated by the elastic fluids, and rendered extremely porous; but that some of it, instead of separating, lengthened into threads, which hardened on its contact with the air. We perceive, likewise, that only a degree more of heat was necessary to render the vitrification complete.

Of the various bodies ejected by the volcano of Stromboli, this kind of scoria appears to be that on which it has acted with most effect. It has not, however, been changed into a true glass, if we except some pieces of very inconsiderable size. The conflagration of Stromboli has never, therefore,
arrived

arrived at this degree of violence; as I could not find, throughout the whole island, either vitrifications or enamels. The natives themselves, indeed, sufficiently satisfied me of their non-existence, as those of the neighbouring island of Lipari are well known to the inhabitants of all the Eolian isles, under the common name of *serizzi*.

But may not the scoria here described as in a great degree filamentous, be considered as a species of pumice? I certainly do not perceive in it the distinguishing characteristics; for the fibrous quality, alone, is not sufficient. I conclude, therefore, that when any stone, in consequence of the action of volcanic fires, passes into the state of pumice, certain determinate conditions are required, either in it, or in the degree of heat to which it is exposed, or, perhaps, in both; which are not yet sufficiently known to volcanic naturalists, notwithstanding the attention they have bestowed on the subject. Of this, the present scoria may furnish an example. The stone which was its base, by the action
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of fire, had been dissolved into lava within the crater; and this lava by the action of elastic fluids, and, probably, by that, likewise, of sulphur, has become a filamentous substance, and, as its filaments are vitreous, appears to shew an immediate disposition to change into pumice; but it was not formed by nature to become that substance, as appears from the small pieces which have assumed the thin vitreous coating. Were the fires of Stromboli more violent and powerful, the stones which are melted and thrown out would pass from the state of scoria to that of perfect glass, without first acquiring the nature of pumice.

The scorix of this kind are never thrown by the volcano, in large pieces, to any great distance, from the great ease with which they break and pulverize.

It is worthy of remark, that not a few pieces of these scorix incline to a cylindrical figure, and that their filaments are parallel to the axis of the cylinder. Both these effects,

effects, in my opinion, may be attributed to the projectile impetus received from the elastic fluids when forced from the lava in the crater ; those pieces not having had time to take a globular form ; both from their sudden cooling and coagulation in the air, and from the smallness of their size.

I shall now proceed to speak of the second kind of scoria, I mean that for which Stromboli is celebrated, and of which its ejections principally consist. This species in its external appearance has no essential difference from the former ; but its specific gravity is nearly three times as great, it is not at all fibrous, and only exhibits the slightest signs of a beginning vitrification. In other respects, like the greater part of scorix, it is not only rough, scattered over with tumours, and irregular figures, and every where scorified ; but it is full of vacuities of round, oblong, and other forms. The largest of these are about half an inch in length, and the smallest almost invisible. They extend through every part of the scoria quite to the inner-

innermost substance, even in the largest pieces; and in the centre of some they are found more numerous and large. Hence it appears that a universal effervescence of the elastic fluids must have prevailed in the substance of these scoriæ, while they were in a fluid state. The internal surface of each of these cavities is, as it were, coated with a dull dark-red varnish, while the rest of the scoria is black. To discover the visible characteristics of this scoria, it must be examined with a lens in the recent fractures. We then perceive that the grain is not very fine, without brilliancy, and of a uniform texture. Its hardness is moderate, its fracture irregular, it gives some sparks with steel, emits a weak earthy odour, and attracts the magnetic needle at the distance of half a line. These exterior marks afford ground to believe that this scoria has for its base the horn-stone; and its component principles confirm the supposition beyond contradiction.

This base, however, is not homogeneous,
since

since it contains felspars and shoerls. On examining it with attention, we perceive that it is interspersed with a great number of small white spots, which form a remarkable contrast with the black ground on which they appear. By having recourse to the aid of the lens, we discover that these spots are scales of felspar. As they are quite flat, wherever they are viewed in the fracture, they appear about the thickness of a line, but longer when seen on a flat surface.

The number of the shoerls contained in this scoria is very considerably less than that of the felspars; but they are much larger. They are of a black colour, and in figure prisms, the length of many of which is five lines, and the breadth two. It is, however, very difficult to extract entire prisms from the scoria, on account of the tenacity with which they adhere to it.

They may be obtained much more easily in certain low bottoms near the crater, where they may be found separated from the scoria,

ria, the small fragments of which are there accumulated in great quantities. Detached shoerls may there be found little altered by the atmosphere and elements; many of them, indeed, fractured and mutilated, but some few entire, and still preserving their prismatic figure, which is octohedrous, and terminated by two pyramids*. They will scarcely cut glass, and consequently cannot be very hard. Their appearance is vitreous, and they seem as uninjured as when they were in the rock, their primitive matrix.

Besides the felspars and shoerls, these scorizæ contain various other small stones, which I, at first, doubted whether I should consider as another species of shoerls, or as what have been called volcanic chrysolites. They have the transparency of glass, and are of

* The original has "two dihedrous pyramids," (*due piramidi diedre*). But (as the German Translator has rightly remarked) who has ever seen a pyramid with only two sides? I have, therefore, with him, omitted the word, which must have been inserted by some mistake. T.

beautiful colours. Some are of a fine grass green, others of a deeper emerald green, and others of a mixture of green and yellow. Some of these qualities, which are common to chrysolites, and to certain species of shoerls, caused me to doubt, when I first examined them, whether I should class them with the former or the latter. But besides that I could not discover that they had any regular figure, the ease with which they were fused with the blow-pipe, determined me rather to consider them as shoerls.

From the observations that have already been made, it seems clear that these two species of scorix are of the nature of porphyry; as they are composed of a horn-stone in which felspars and shoerls are incorporated.*

* It appears to be proved by the most recent discoveries of chemical analysis, that the base of the greater part of porphyries is shoerl in the mass, or horn-stone, or trapp; though it cannot be denied that this base is likewise frequently siliceous. Many of the lavas, therefore, of the Phlegrean Fields, which I have described in the first volume, may be referred to this kind of stone.

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But before I dismiss this second kind of scoria, I must make one more observation on it. Some pieces of this scoria lay near the apertures, from which the streams of smoke I have already mentioned, arose, to the west of the volcano. I collected some of these, which had almost stopped up one of the orifices through which the fumes issued; and which, consequently, was strongly acted on by them. These pieces had undergone changes similar to those of the lavas of Solfatara. They had lost their black colour, were covered with light-yellowish crust, and were become so soft that they might be cut with a knife. The shoerls, however, in the part where this alteration had taken place, had undergone no change. But the sulphureous acid which had acted on this scoria, besides having in part decomposed it, had likewise produced in its cavities, small aggregates of sulphate of alumine (alum) and sulphate of lime (gypsum). This observation I have had an opportunity of making, not on volcanic products long since decomposed, which decomposition

there is every reason to believe must have been effected by the means of sulphureous acids ; but, instructed by nature herself, on a product actually undergoing decomposition, and thus presenting an incontestable proof of the power of these acids to decompose such substances.

I have denominated the principal matters ejected by Stromboli, and on which I have hitherto treated, scorix ; though, according to the judicious and just remark of M. Dolomieu, these differ from lavas only in having undergone greater alteration within the volcano, having been more inflated, and acquired a surface more rugged, and of a more irregular form ; and such precisely is the appearance of the stones thrown out by Stromboli. I am aware, however, that the difference of these circumstances is not intrinsic and essential ; and that, therefore, what I have termed scoria may be likewise called lava, only more changed in the volcano, since it is in substance the same matter melted by the fire, and differently modified

dified by the elastic gases. I think, notwithstanding, that I have expressed myself with sufficient propriety, when, in the last chapter, I said that the lava swelled, sunk, burst, and was thrown up into the air, though I have afterwards called the congealed pieces of it scoriæ, since they possess the characteristics of that substance.

With respect to the matters that ferment and boil up in the crater of Stromboli, I shall here make a remark which may deserve consideration. This volcano, besides the singularity of having been in a continual state of eruption from time immemorial, has also this other, that the substances it ejects are more repeatedly acted on by the fires of its crater than in other volcanos. The latter being situated at the summit of steep mountains, having once thrown out their ignited stones beyond the edges of the fiery gulf, never receive them again, as they pour headlong down their sides. But the crater of Stromboli is situated half-way up the mountain, and sur-

rounded, except only on the side which faces the north, by steep precipices; so that, besides the scoriæ which are thrown up perpendicularly, and fall again immediately into it, great quantities which are thrown beyond its edges roll down the declivities, and return again into it. When we consider, therefore, for how many ages this recurrence of burning matters into the volcano has continued, we might expect, that from the continued action of the fire they must approach very near to a vitreous nature, or rather be changed into perfect glass. Yet this is by no means the fact. I caused a quantity of scoria to be dug up from the depth of eight feet, at no great distance from the mouth of the crater, and found it exactly resemble that on the surface, though it must have been ejected so long a time before. It is likewise to be remarked that the shoerls in the recent scoriæ are as entire, and as completely crystallized, as those in the most ancient.

These observations are a certain, and, in
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my opinion, elegant proof, that the activity of the fire has never been, in former ages, either greater or less than it is at present. Not less, since then the fusion of the matters in the crater would not have taken place, and, consequently, there would have been no eruptions; nor greater (at least not in any considerable degree), otherwise the scoriæ would have been completely vitrified, and the shōerls fused, as we find them by our common fires, when intense.

Hence, likewise, appears what little foundation there is for the opinion of some naturalists, who have supposed that volcanic glasses owe their origin to the refusion of lavas; since, as we have seen, no true glass has ever been thrown out by Stromboli, notwithstanding the multiplied refusions of the ejected scoriæ, or scoriaceous lavas, if any should choose to call them by that name.*

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* With respect to the matters ejected by Stromboli which scorify and do not vitrify, it may, perhaps, be said that this does not happen, because they have not

But it is time to consider the third species of scoria. This properly belongs to the ancient volcano, and is found, on removing the sand, at a small depth, on the east side of the island, a little above the foot of the mountain. It is disposed in strata forming one body with the subjacent lavas, which, at some distant period, flowed from the summit of Stromboli into the sea. The inhabitants make great use of this scoria to build their houses, as it is very firm, and very light, which lightness arises from the small quantity of matter it contains in proportion to its bulk, and its great porousness. As the partitions which separate the cells or pores are very thin, it is difficult properly to examine this scoria, which bears the marks of the highest antiquity. After as attentive an

caloric enough to become glass, but from the quality of these matters, which, originating from the horn-stone, only produce scorification, and that from the quantity of iron they contain.

This reasoning may, at first view, appear plausible, but is sufficiently refuted by the easy vitrification of these scoriæ in the furnace, as we shall see presently.

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examination as I could bestow, I discovered in it black shoerls, and white felspars. The body of its substance does not differ, that I could perceive, from that of the other two kinds.

Having thus described the three kinds of scorizæ of Stromboli; though I do not mean to say that other enquirers may not discover more species, I shall next proceed to enumerate and describe the lavas, which, for the sake of order, I shall divide into porous and solid, beginning with the former.

I. This lava forms an ascent of some hundred paces, to the west of the island. The eye does not hesitate a moment to recognize it as a product not at all differing in substance from the second species of scorizæ. It has the same ground, consistence, and colour; and contains the same felspars and shoerls, both of which are in like manner unmutilated, and have the same crystallization. It likewise gives sparks, in the same manner, with steel. But the size and number

ber of its cavities, or pores, is less, the solid parts are more smooth, nor have they in their grain that irregularity which appears to be inseparable from scoriæ. We might therefore suppose, that it is the produce of the present volcano; nor should I object to that supposition, were the course of the lava on that side; but I find it is directed towards the summit of the mountain, where there is every reason to believe the greater volcano anciently was situated. I am, therefore, of opinion that this was its source.

II. This lava is less porous. The grain has somewhat of a siliceous appearance. It is smooth to the touch, and gives sparks plentifully with steel. It contains but few felspar scales, but innumerable shorls. It lies on the south side of the mountain, in large single stones.

III. The difference between this lava and that of No. II. is but small, and consists in its greater porosity, and a feeble argillaceous odour. This lava is found scattered

over the island. The petrofilex is the base of both these lavas.

I shall now speak of the solid lavas, which I so term, not because they are without pores, but because their pores are so minute that they escape the eye.

I. This lava, notwithstanding its solidity, is friable, and gives sparks, feebly, with steel. It abounds in felspars, and still more in shoerls. It is of a dark-grey colour; its base is horn-stone, and, consequently, it emits an earthy odour.

II. This second species of solid lava is still more friable than the former, and it has a considerable argillaceous odour. It contains no shoerls, but so abounds in felspars that they occupy more than one third of its mass, and are easily distinguished, as they are of a shining whiteness on a brown ground. Their lamellæ are distributed equally through its whole contexture. I collected both this lava, and that of No. I.
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from several currents of it on the south-east side of Stromboli.

III. I am in doubt whether I ought to call this stone a lava, as it is a porphyry of a beautiful dark-red colour, which changes to a black as soon as it is exposed to the activity of the furnace. The place, likewise, in which I found it, contributes to increase my doubts. This was a hill of tufa forming a large inclined stratum, on the south-east side of the island, within which it is found in large masses. I was led, therefore, to conjecture, that both this porphyry and the tufa might have been thrown out by the volcano without having been exposed to the violence of the fire. I am still, however, unable to form any determinate conclusion, since I am in possession of several other specimens of porphyry, which bear indubitable marks of having been fused, though they still retain a beautiful red colour, as will be seen when I come to treat of the island of Lipari. However this may be, this stone has for its base the petrofex, is spotted with

with white felspars, and takes a fine and brilliant polish.

IV. This lava, which is found in a long-continued current, on the south-west side of Stromboli, contains, as usual, scattered felspars. It is of a black colour, of the horn-stone base, and emits a strong earthy odour. It is accompanied with various greenish and black shorls. A number of curling veins and waves appear in it, which, probably, were produced when it flowed from the mountain. Though it is solid, it has in it several small cavities, all of which are long ellipses, all placed in the direction of the current from which they certainly derive their figure.

These are the scoriæ and lavas found at Stromboli, omitting a few varieties, which would only swell the work, without adding to its utility.

According to the division I have made, after the lavas, I should proceed to speak of
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the tufas, as I have already given the reader to understand they are not wanting in some parts of the island. But I think I fully describe these, when I say that they are an argillaceous earth, pulverizable, extremely bibacious, of a grey colour, containing fragments of felspar and shoerl, and which, in the furnace, hardens without melting. Such, at least, are the characters of the tufas which I observed at Stromboli.

I now proceed to the fourth kind of the volcanic productions of this island, the pumices. These are found on the east side of the mountain, at about one third of its height, on the sides of some path-ways which cross several vineyards, and in the furrows made by the descent of the waters. They are not found in masses, and still less in currents, but in small pieces, which are not numerous, and it is easy to perceive that they have been brought above ground by the labours of men, or by the action of the rains; and following the traces they afford, we find them buried under the sand, at the depth

depth of several feet. Here they are but thinly scattered; and are in the same state as when thrown out of the volcano. I cannot pretend to ascertain from what crater they originated, whether the ancient, the present, or some other, the remembrance and traces of which are lost; as nothing affords any light to direct my researches relative to this obscure question. I found them in no other part of the island. As they do not differ from the more common and known species, it would be superfluous to give a long description of them. I shall only say that their base is petrosiliceous, with a mixture, as usual, of felspars.

Stromboli has, therefore, at some other period, thrown out pumices, though it does not eject them at present. A similar change, though on a larger scale, we find likewise take place in Vesuvius.

The different kinds of scorix and lavas being exposed to the fire of the furnace in separate crucibles, the base, whether of petrosiliceous
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flex or horn-stone, changes into a shining, ebullient, but hard glass, with a fusion of the shoerls, but not of the felspars. From the pumice was obtained a glass, lighter from the multitude of its pores, of a grey colour, and dully transparent.

It now remains to speak of the iron, the fifth and last of the volcanic productions which I found on this island. This is specular. I am not ignorant that this species of metal has been likewise observed in other volcanos ; but it gave me pleasure that I was the first who had discovered it in the Lipari islands ; and this pleasure was considerably increased, when I perceived that the crystallizations of this iron were much larger than those which had been observed by others ; and, consequently, much better adapted to shew and explain their formation. It is found on the southern side of the island, at the distance of somewhat more than a mile from the inhabited part, in a rock of lava, which descends almost perpendicularly into the sea, from the height of
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about a hundred and fifty paces. Some natives of Stromboli having shewn me a small specimen of this iron, without knowing what it was, as one of the rarities of their country, I was very desirous to obtain some others, but such as might shew the iron still adhering to the matrix, as these were detached pieces, found on the beach, under the rock. But to procure new pieces of this production, neither entreaties, nor any common offers of reward availed; and, to say the truth, so great was the labour and danger of obtaining them, that they never could be sufficiently paid for. To get at these stones, as they call them, it was necessary to go by a very dangerous way, scarcely passable by the wild goat, much less by men, and therefore called, very properly, *il malo passo*, the bad or dangerous road. But, to reach the precise spot where the iron is found, still greater danger must be encountered, as the rock, besides its extreme steepness, is partly fallen down, and the rest on the point of falling; and it is very difficult to find firm footing on it, without slipping, and falling

headlong into the sea. The desire of gain, however, added to the habit in which these peasants are of passing cliffs and fearful precipices, induced two of them to undertake this enterprise, which they successfully executed, bringing back with them some very beautiful pieces of this iron which they had separated from the lava with a pick-axe. From them I learned, that the rock has clefts in many places, and that within those clefts the iron is found.

This metal is crystallized in laminæ, vertical to the mother rock, in which they are so firmly infixed, that they must be broken to obtain them detached. The two faces of every lamina or plate are parallel to each other, or nearly so. In general, the plates, at a first view, appear oval; but, when examined with more attention, they are found to be polygons. The figure of these polygons is extremely diversified. Sometimes they are triangles, terminating, in the upper part, in an obtuse angle; and sometimes in a right, or acute angle, though this but rarely.

rarely. Some of those plates have six, seven, eight, and sometimes more, sides; nor is there less variety in the length of the sides, or the measure of the contained angles. The sides are frequently cut by plates, which are triangular, quadrangular, rhomboidal, or of other polygonal figures. Nature, therefore, in the formation of this metal, appears not to have prescribed to herself any single form of crystallization; or, at least, if she has, it is not easy to discover the simple primitive figure from which has arisen so great a variety.

The plates or faces have such a brilliancy and polish, that if the finest steel be not inferior, it certainly is not superior to them in beauty. They reflect the light equally with the most perfect mirrors. The largest exceed four inches in length, and three and a half in breadth; but there are innumerable others which are smaller; and only one inch, or the half, the third, or the quarter, of an inch, until they become so minute as to be only visible by the microscope; but they are always crystallized in one of the figures already

mentioned. A single lamina is never seen, but they are always in groups, which groups are sometimes twenty or more inches in circuit. The number of them, therefore, is very great.

I must not here omit to mention a peculiar circumstance, which usually attends these crystallizations. The circumference of these thick metallic groups is formed of laminae so minute, that a strong lens is necessary to discern them; but they become gradually larger as they approach the centre, where they are largest of all. There are also places in these groups where Nature seems rather to have sketched than completed her work. We find there groups or small masses of iron which present only the first principle of crystallization. In others we do not find even this sketch, but only a crust attached to the matrix. There are also places in which a number of small tumours arise, that viewed with the naked eye appear to be without form, but when examined with the lens, are discovered to

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consist of a multitude of small laminæ irregularly conglutinated. In the same manner, some crusts are formed, in some places three lines in thickness, which, both internally and on the superficies, are found to be composed of an aggregate of laminæ thrown irregularly on each other.

In reference to some observations I shall hereafter have to make, I must mention that some of these aggregates of laminæ are either entirely covered with a coating of sulphate of lime, so that it must be taken off to get at them, or at least only the upper part of them rises above it. This coating is of a very white colour, and so strongly attached to the iron, that it appears like wax that has been poured over it and hardened.

The colour of these laminæ, in general, greatly resembles that of the finest and most brilliant steel; except some which have a violet tincture. They are as resplendent in the fractures as on the faces. Notwithstanding

ing their great hardness, they are nearly as brittle as glass.

On carefully examining these laminae, a phenomenon presented itself which increased my attention. This was some scales parallel to each other, which arose from the faces of these crystals, and induced me to suspect that their composition might be the result of a number of small leaves united and conglutinated together. An inspection of the larger laminae convinced me that this conjecture was well founded; for, on breaking them crosswise, I frequently found in the fractures very small leaves. There are also some which very evidently shew them, and in great numbers, on their faces. A leaf, for example, may occupy a sixth part of the face, and there end. Further on, under that, another appears, which extends another sixth, and then terminates like the former. Still farther, under the second leaf, appears a third, which extends only a small space; and in like manner others: so that the lamina will be the less, the smaller the number
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of the leaves of which it is composed. I shall here avail myself of a comparison, which, though not very scientific, will aptly explain what I mean. When a number of leaves of paper are, first, rolled up, and afterwards spread out on a flat surface, it will happen, on their unrolling, that each will separate a little from the next, so that they may all be numbered; and it will be evident that the first, which is above all the rest, renders the heap larger, and that the leaves being successively taken away, the heap will be diminished, until it will at length only consist of the single last leaf.

The laminæ, however, are not all composed in this manner. In some, the component scales are conglutinated in such a manner that they do not appear, and the fracture presents a continued surface. Yet there are but few laminæ so smooth on both their faces as not to shew the presence of some leaf. More than once I have found on one lamina others attached which shewed they were of later formation.

These facts, when compared, must remove every doubt with respect to the nature of the formation of these noble crystals, as it is manifest they are composed of a greater or less number of small plates, which, placed upon, and adhering to, each other, form the larger laminae.

Among all the volcanic productions which I met with and collected in my travels, there is not one which gives sparks so plentifully with steel, or influences the magnetic needle at so great a distance, as this of which I now treat.

Almost every lamina, part, or fragment of this production possesses polarity, attracting the magnetic needle at one end, and repelling it at the other; which attraction and repulsion are equal in force. The same powers of attracting and repelling are equally found in the crusts of iron apparently not crystallized, and in their parts.

Notwithstanding, however, its power to
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move the magnetic needle, it is scarcely at all acted on by the magnet, at least, not unless it be reduced to very small particles.

When approached to the Leyden phial, it freely conducts the electric shock.

The furnace has no other effect on it than to deprive the laminæ of their brilliancy, and diminish, in a small degree, its magnetic virtue, which is not destroyed even by the fusion of the laminæ; to obtain which the blowing pipe is not sufficient; but oxygenous gas (dephlogisticated air) must be applied for about two minutes, as one will not be long enough. The little ball into which a small lamina of specular iron is converted, loses on its surface all brilliancy, and acquires the colour of lead exposed to the air. Internally, however, it still retains some splendence; but the friability of its parts is increased, and it gives but few sparks with steel. The same change takes place in this metal which is so frequently observable in other bodies after having been in a state of fusion:

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it is interspersed with small air-bubbles, and rendered, in a manner, spongy.

Such are the principal properties of the specular iron which I discovered at Stromboli. But it is of importance to know, of what nature is its matrix. This is a lava which does not essentially differ from those lavas of this volcanic country which are of the horn-stone base, except that it has undergone great changes. It is so friable, that it may be scratched with the nail. Instead of being black, or dark brown, it is of a cinereous, and, in some places, of a reddish colour. It is extremely porous, and, therefore, light; and its grain rough and dry, not unlike that of some sand-stones. Its odour is argillaceous, and it adheres strongly to the tongue, like a burnt bone. When immersed in water, it imbibes it with a hissing noise, and saturates itself with it.

Besides that it gives no sparks whatever with steel, this lava has not the smallest effect on the magnetic needle, except when

Some small particle of specular iron still remains within it; for though the latter principally covers the external surface of the lava, a number of microscopic laminæ glitter, here and there, in its internal pores.

The small felspar crystals in this changed lava are entire, but their natural brilliancy is diminished, and they are cracked. It is necessary to look with attention to distinguish them from the substance of the lava, as their colour is the same; but they are much more easily discernible when the lava has been exposed to the furnace, since they have then acquired a greater degree of whiteness, and are seen through a thin blackish crust of enamel, into which the surface of the lava is changed. This, however, in a few seconds, is entirely freed from the oxygenous gas, and a homogeneous but ebullient enamel produced.

The great analogy between the alteration undergone by this lava and the changes
pre-

produced in many others by the action of sulphureous acids, sufficiently shews that it proceeds from the same cause. This is likewise evidently confirmed, by the thin crusts of sulphate of lime with which it is coated, and which have been generated by the sulphureous acids, combined with the small portion of lime contained within the horn-stone.

It will here not be improper to give a concise account of some observations of a similar kind with those I have made, that, by comparing both, we may be enabled to deduce such conclusions as may elucidate the subject.

The first author, who, to my knowledge, has spoken of crystallized iron adhering to volcanic matters, is M. Faujas in his *Minéralogie des Vulcains*. He tells us that he found at Volvic, in Auvergne*, a homogeneous and heavy lava, from the surface and fissures

* Now the department of Velay. T.

of which projected a great number of small thin plates of iron, which had the lustre of the finest polished steel. Though he does not give their size, there is reason to believe they must have been almost microscopic; since he says a lens of considerable magnifying power was necessary to discover that some of these plates were segments of hexagonal prisms, and that others consisted of two hexagonal pyramids joined at the base. They were attracted by the magnet. The lava to which they adhered, according to him, was basaltic, but greatly altered, having become white, cracked, friable and softened.

M. De Larbre, physician at Riom, examined with great care, both the iron of Volvic above mentioned, and that of the Puy de Dome and Mont d'Or in the same province*. The crystals of the latter iron are sections of octahedrons similar to those of alum, and

* See his dissertation in the *Journal de Physique* par l'Abbé Rozier, l'an 1786.

sometimes

sometimes perfect octahedrons. It is at Mont d'Or that the crystallizations, or plates, of specular iron are most beautiful and distinct. The largest are about an inch and a half in breadth, somewhat more in length, and about a line and a half, or, at most, two lines, in thickness. The faces of the plates, when viewed with the lens, discover streaks and diminutions which prove the accumulation of a number of small laminæ.

The specular iron of the three abovementioned places in Auvergne possesses a magnetic quality, and many pieces of it attract the magnetic needle on one side, and repel it on the other.

M. De Larbre remarks, that the specular crystallized irons of Mont d'Or, the Puy de Dome, and Volvic, have the same matrix, that is, a cellular and pumiceous lava; and that this lava has been more or less changed by the action of acids.

Lastly, a third specimen of the crystals of
specu-

specular iron has been described by the commendator Dolomieu, which was found by him on some solid lavas, at Jaci Reale, and on different scorix, which had been changed and softened by acid sulphureous vapours, in the crater of Monte Rosso. Those found at the former place were thin shining plates, of a regular hexagonal figure, hard, slightly attracted by the magnet, and the largest not exceeding a line and a half. Those of Monte Rosso consisted only of small, thin, irregular scales.

When I compare these observations on specular iron with my own, I find that they greatly resemble them. The iron described by these authors is, like mine, crystallized; but the crystallization is different, and the laminæ of the iron of Stromboli are larger than those of that of Auvergne and Etna. The beautiful lustre, like that of steel, and the magnetic virtue, are the same in both. The formation of the crystals of Auvergne is observed to arise from the apposition of small scales, as I observed in mine, only that,
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in the latter, it is more distinctly seen. Lastly, the lavas in which this specular iron is found, excepting those of Jaci Reale, have all undergone a change.

This identity in the effects naturally induces to conclude an identity of cause. The three naturalists above cited are of opinion, that the formation of these martial crystals is to be ascribed to the volcanic fire; by the action of which the metal was separated from the lava of which it made a part, and sublimed; and that, afterwards, falling on the surface, and into the clefts, it there attached and collected, taking a regular form. This explanation is, certainly, not only the most natural, but is confirmed by facts; since iron, in crucibles, using certain precautions, crystallizes in a similar manner, as has been observed by MM. Grignon, Faujas, and Buffon. I am therefore of the same opinion relative to the specular iron of Stromboli, that is, that the vehement heat of the fire deprived the lavas of this metal, by subliming it, which afterwards attached to their surface,

surface, producing laminated crystals, more or less large, and more or less numerous, with those varieties which usually accompany crystallizations. In fact, while almost all the other lavas of Stromboli move the magnetic needle, those which have crystallizations of iron on their surface, have not the least effect on it; no doubt because they are in a great measure deprived of that metal. But as, in general, the fire has acted on the other lavas, in the same manner as on those which exhibit the specular iron, and as, besides, the specimens of the latter are not numerous in volcanized countries (since, excepting the places above mentioned, and some of the Phlegrean-fields*, I know none where this crystallized iron is found), it seems not to be doubted but some other circumstance, besides the fire, must concur to its formation; which perhaps may be the union of the iron with the muriate of ammoniac, as it is well known that by such a union that metal is sublimed and passes into the nature of specular iron.

See Chap. V.

We have seen that the specular iron of Stromboli is, in many places, covered with sulphate of lime; and since this sulphate derives its formation from the action of the sulphureous acids, they must have acted likewise on the metal, the crystallization of which is anterior in its origin to this neutral salt, which closely invests and covers it. But though these acids are sufficiently powerful to attack and decompose the most solid and hard lavas, they have not been able to make any impression on the specular crystals, which have likewise resisted all the shocks of other destructive causes, among which the æriform fluids floating in the atmosphere are no small part, and still retain that brilliant lustre which they received at first, notwithstanding the antiquity of their production, which is probably the same with that of Stromboli itself, of which the annals of time afford no memory. For, in fact, these crystallizations being found adhering to a rock formed of strata of lava, which serves as a foundation to almost the whole superstructure of the mountain, we cannot recur

to any times known to history, but must go back to that most remote period in which the island was formed by subterraneous conflagrations.

We have now finished the description of the volcanic products of Stromboli ; I mean the sand, scorix, lavas, tufas, pumices, and specular iron. Omitting this metal, the pumices, and the tufa, three productions which occupy only a small corner of Stromboli, this island may be said to be formed, as far at least as externally appears, of scorix and lavas ; and since these scorix and lavas have been shewn to derive their origin from porphyry rocks, partly with the horn-stone base, and partly with that of the petrosilex, it must be concluded, that the material origin and increase of Stromboli is to be attributed to porphyry, which, melted by subterranean conflagrations, and rarified by elastic gaseous substances, arose from the bottom of the sea, and, extending itself on the sides, in lavas and scorix, has formed an island of its

present size. These porphyry rocks likewise still furnish matter for the present eruptions.

Before I conclude this chapter, I must not omit two enquiries which I consider as of no little importance. In my researches relative to volcanos, I have proposed as a rule, to subject the volcanized bodies to the action of the furnace, in order to compare the activity and manner of action of the subterranean fires with that of our common fire; and I have found this practice, and expect still to find it, not a little instructive. But with respect to the Eolian isles, which I have studied with the greatest attention, I have judged it proper to make other experiments of the following kind.

Having ascertained, by various observations, the different kinds of primitive rocks, which by their fusion have contributed to the formation of each of these islands; I resolved to subject to the furnace rocks of a similar nature, but brought from countries

not

not volcanic, remarking in what manner they were affected by our common fire, and thus make a comparison of another kind, which must be of equal utility with the former.

To this enquiry, which has perhaps been first made by myself, I shall add another, relative to the accounts left us by the ancients concerning the conflagrations of Stromboli, which I shall state and consider. I shall proceed in the same manner with respect to the other islands, as an examination of these accounts will enable us to compare the present state of these countries produced by subterraneous conflagrations with that of former times.

With respect to the first object of research, as the principal materials of Stromboli derive their origin from rocks of porphyry, I shall briefly relate the results of experiments made on different kinds of this stone, in its natural state, exposed, in the usual manner, to the furnace; and I request my courteous

readers to endure the fatigue of reading these experiments, since I endured the fatigue of making them.

I. This porphyry is Egyptian. Its colour is a dark red, its base compact; and its recent fractures fine and earthy. It gives sparks plentifully with steel, and breaks into irregular pieces. The base includes a few black, shining, linear, and opaque, shorls; with abundance of felspars of two kinds; the one quadrangular, of a pale red colour, and almost opaque; the other likewise quadrangular, but transparent and brilliant. It is well known that this porphyry takes a fine polish, which renders it very beautiful to the eye.

After remaining twenty-four hours in the furnace, it is perfectly fused; when it is changed into a black enamel, minutely spotted with ash-grey points, which are felspars. These, therefore, continue entire. This enamel abounds in pores, gives fire with steel, but less than the porphyry,

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has a lively lustre, and is transparent in the angles.

If this stone remains in the furnace eight-and-forty hours successively, it becomes a compact enamel, uniformly black, from the complete fusion of the felspars, which then form with the base one homogeneous whole.

It has been the opinion of many celebrated naturalists, that the base of the Egyptian porphyry is a jasper; but the easy fusion of it in the glass-furnace convinces me of the contrary; and I find one of the most eminent of our modern lithologists agrees with me in that conclusion. To obtain, however, as much certainty as possible, on this point, which I considered as important, I exposed some jaspers to the heat of the same furnace, but no fusion took place. The following are the results of my experiments on five different kinds of jasper, which I exposed, in small fragments, to the fire of the furnace, during forty-eight hours.

The first jasper was of the yellow colour of honey, interrupted with red streaks, with a grain rather filiceous than earthy, and received a beautiful polish, though with little lustre. This became lighter, extremely friable, of a colour approaching that of iron, the red streaks having acquired that of sealing-wax. No fusion followed, except in some parts, which, being higher than the rest in the crucible, had been more exposed to the violence of the fire, and were covered with a very thin vitreous coating.

The second jasper was of the yellow colour of wax, of a fine grain, and filiceous, gave sparks plentifully with steel, and took a very beautiful polish. This only underwent a considerable degree of calcination, by which it became light, friable, full of cracks, and of a blackish-brown.

The same colour, and the same calcination, without any sign of fusion, was observable likewise in a third jasper, of a blood-red

red colour, of an appearance between the siliceous and the argillaceous, and less hard than the second kind.

A fourth and fifth species equally resisted fusion. One of these was of a dark-red, and the other of a mixed colour. Both were of a grain rather siliceous, gave sparks with steel, and, like the other three, were entirely opaque.

These five kinds of jasper were brought, some from Lower Hungary, and some from Germany; and all the five, as has been seen, were infusible in the glass-furnace.

The experiments I have here described perfectly agree with those of M. D'Arcet, who found the same infusibility in four kinds of jasper, notwithstanding they were reduced to powder, and exposed to the action of the most violent fire employed in the manufacture of porcelain. M. Mongez found this stone equally infusible with the blowing-pipe.

These

These facts, therefore, convince me that the base of the porphyry cannot be a jasper; for, had it been, it would not have melted. I must add, likewise, that I obtained the same easy fusion from two other kinds of oriental porphyry.

Dolomieu and Delametherie, who both agree that the base of the Egyptian porphyry is not jasper, differ, nevertheless, as to what this base is, the former maintaining it is petrosilex, and the latter, that it is horn-stone. The chemical analysis, however, adduced by M. Delametherie of a red porphyry, similar to mine, which shews its base to be horn-stone, induces me to prefer his opinion to that of the other French naturalist. I have not yet had leisure to examine chemically the Egyptian porphyries which I exposed to the action of the fire; but of this operation, which I certainly shall not omit, I shall give an account hereafter, when, in another part of this work, I shall have occasion to say more of volcanic porphyries.

phyries. At present, let us return to our subject.

II. This porphyry, which has the petrofilex for its base, is of a blueish red, of a grain moderately fine, angular in its fractures, of middling hardness, and heavy. It contains very brilliant quadrangular scales of felspar, and a few small leaves of black mica.

In the furnace this stone produced a compact enamel which gave sparks plentifully with steel, very even in its fractures, transparent at the angles, and of a dark cinereous colour, with some black spots, which were half-fused mica. The felspars remained entire but calcined. This enamel, on the surface where the heat had acted with most violence, was invested with a very thin vitreous coating, which was semi-transparent, and of a topaz colour.

III. In this porphyry, the felspars, which were in round scales, but little brilliant, and
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of a yellowish colour, are included in a petrosiliceous ground, of a reddish brown, of a scaly fracture, and which contains points of steatites,

To melt it entirely, it requires a continuance of thirty-six hours in the furnace, when a dully transparent, hard, compact glass is produced, of the colour of the common chalcedony, in which the felspars are preserved entire, though changed to a milky whiteness,

IV. The petrosilex, which is the base of the present porphyry, and which, both in its substance and grain, approaches very near to the common flint, is semi-transparent, of an olive green; its felspars are quadrangular, and of a changing aspect,

It is infusible in the furnace, except on the surface, which is changed into a transparent and compact glass, without the fusion of its felspars,

V. The

V. The felspars in this porphyry are very brilliant and sparkling : they are found in a petrosiliceous ground, of a pale rose red, scaly, opaque, and of moderate hardness.

In the furnace the felspars lose, by calcination, the beauty of their changing colours, and their compactness from the number of cracks they contract : the petrosiliceous base is likewise transmuted into a dully transparent glass, of the colour of foot.

VI. This porphyry is extremely compact, hard, and heavy. Its base is a clear red petrosiliceous, of an equal grain, smooth, and containing small quadrangular scales of brilliant felspars.

A continuance in the furnace of not less than forty-eight hours is necessary for this porphyry to acquire an imperfect vitrification. It is then transparent at the angles, of a black colour, and has lost its natural hardness : the felspars it contains, however, shew no signs of fusion.

Besides

Besides the six porphyries already described, the base of which is petrofilex, I made experiments, in the same fire, on some specimens of pure petrofilex, of which I shall not give a particular account, to avoid superfluous prolixity. I shall only say, in general, that I found them refractory, that they abounded in filex, and that they formed, as it were, the point of transition of the petrofilex into the filex. On the contrary, all the rest are more or less fusible.

I likewise made similar experiments on some natural porphyries, with the hornstone base; many of these having likewise suffered the fires of Stromboli.

VII. The base of this porphyry is not sufficiently hard to give sparks with steel. It is of a dark grey, earthy, unequal in its fractures, soft to the touch, yielding a sensible argillaceous odour, and containing, besides some grains of a crystal and pellucid quartz, a great number of white felspars, which, being easily cut with a penknife,

shew

shew how great a change they have undergone from the influence of the seasons and the atmosphere.

The furnace changed this porphyry into a black scoria of little consistence, and its felspars assumed a vitreous appearance, though without any sensible fusion.

VIII. This stone, at first sight, would rather be taken for a granite than a porphyry, as we find in it quartz, mica, and felspar, did we not observe that the three latter substances are united in a common cement or paste, which is a horn-stone, rather soft, of a cinereous colour, and an argillaceous odour.

The three substances remain entire in the furnace ; but the ground in which they are included, is changed into a hard, black, and shining enamel.

IX. The base of this porphyry is a horn-stone of rather a fine grain, sufficiently hard to give sparks with steel, of a greenish colour,

bur, and emits a strong earthy odour. Some of its felspars form rather large irregular masses of a brick red colour; and others small quadrangular crystals of a light yellow colour.

This stone is changed by the furnace into a black enamel, moderately inflated, and hard. Its felspars, however, remain entire, only with the change of their red colour into a white.

X. The horn-stone of the present porphyry is laminated, of a smooth surface, easily cut with the knife, and of a reddish-green colour. Its felspars are rhomboidal; and some are four lines and a half in length and three in thickness.

In the furnace they remain unaltered; but the ground of the porphyry is changed into a black and hard scoria, full of little bubbles.

I shall omit the description of many other porphyries, the base of which was in like manner

manner horn-stone, and on which I made the same experiments, since the results were essentially the same with those already stated. I shall only mention that these different species of porphyry, some of which had the petrosilex, and others the horn-stone for their base, were brought from those parts of Hungary and Germany, where, according to the observations of scientific travellers, no traces whatever of volcanization are discoverable.

If we now compare the effects of the volcanic fires and our common fire on these various kinds of porphyries, we shall find that the principal difference is, that the furnace vitrifies them, destroying their original structure, whereas the fires of Stromboli seldom change their natural lineaments. In both cases we find the felspars, for the most part, remain infusible; but what appears of most importance to the present object of our research is, that the stones with a petrosiliceous base, as well as those with that of horn-stone, may be fused in a strong heat (such as

that of the glass furnace) and without its being necessary to have recourse to the most vehement that can be procured.

From these experiments we learn, therefore, in what manner the subterranean fire of Stromboli, even though we should not consider it as extraordinarily active, may have been able to melt, and may still continue to liquefy, the rocks of porphyry which have existed, and still exist, in the abysses of that mountain. The facility, likewise, with which its lavas may be re-melted in a glass furnace, is a strong confirmation of the hypothesis.

With respect to the time when this volcano began to exert its activity, and to melt these rocks, we are profoundly ignorant, this being an epocha anterior to all history. We must be contented with the imperfect accounts the ancients have left us of the conflagrations of Stromboli, which did not burst forth in their time, but ages before. Of these accounts I shall proceed to give a concise

cise view, this being the second enquiry it was proposed to make, and it will necessarily be brief, as the notices left us on this subject by the ancients are extremely few.

Eustatius, Solinus, and Pliny, inform us that the flames of Stromboli are less powerful than those of the other islands of Lipari, but that they exceed them in clearness and splendour. These writers, however, were only the copiers of Strabo, or perhaps some abridgment of him, in which he is copied incorrectly. We shall therefore have recourse to that celebrated Grecian geographer himself; who, after having mentioned Lipari and Vulcano, and informed us that Stromboli likewise burns, tells us that the latter island compared to the others, is inferior to them in the violent eruption of its flames, but that it exceeds them in their brightness*.

* Ἐστὶ δὲ (Στρογγύλη) καὶ αὐτὴ διάπυρος, βιά μιν φλογὸς
λαίπομένη, τῷ δὲ φέγει πλεονέκτους. Lib. VI.

It is evident, that by "the others," Strabo means Vulcano, which was the only one of the Eolian isles, besides Stromboli, in a state of conflagration in his time. When I compare Stromboli with Vulcano, I perceive that, even now, there is this difference between the two islands, that the flames of the former are much more resplendent and lively than those of the latter, as will appear when we come to treat of Vulcano; but I cannot say that those of Stromboli are less violent, as the contrary is certainly the fact. We must, however, conclude, that, in those ages, the eruptions of Vulcano were very strong and frequent, which agrees with the testimony of Diodorus, and that of Agathocles as cited by the Scholiast on Apollonius; the former of whom asserts, that, in his time, Vulcano and Stromboli vomited great quantities of sand and burning stones*;

* Ἐν δὲ τῇ Στρομβόλῃ, καὶ τῇ Ἱέρᾳ, μέχρι τῆ νῦν, ἐκ τῶν χασμάτων ἐκπύσσει πνεύματος μέγεθος, καὶ βρόμος εξαίσιος. ἐκφυπᾶται δὲ καὶ αμμος, καὶ λίθων διαπύρων πλῆθος, καθάπερ ἐστὶν ὄραν καὶ περὶ τὴν Αἴτναν γινόμενον. Lib. V.

and

and the latter, that these two islands threw out fire; both by day and night *.

There is another circumstance mentioned by the Sicilian historian which deserves notice. This is, that a wind issues from both these islands with a great noise. This, in some measure, agrees with the observations I made at Stromboli; and is still more applicable to the other island, as will be seen when I come to give an account of Vulcano.

Philip Claverius, in his *Sicilia Antiqua*, speaking of Stromboli, tells us that its crater is situated at the summit of a mountain, from which it pours forth, both by day and by night, with a horrible noise, bright flames, and great quantities of pumice †. In one of the plates prefixed to his work, this island is represented with

* Αἴτινες (ἰσὰ καὶ Στρογγύλην) ἡμέρας καὶ νυκτός, πῦρ ἀφίσσιν.

† Strongule hodieque liquidissimam flammam, et pumices magna copia, ex vertice, ubi craterem habet noctes atque dies, cum fremitu horrendo, eructat.

the smoke rising from the summit of the mountain.

Nearly one hundred and seventy-three years have now elapsed since this author travelled in Sicily. Ought we then to conclude, that, at that time, the mouth of the volcano was situated at the summit of the mountain? Had the learned antiquary himself visited the island, I could not have objected to his evidence. But he not only does not say this, but the contrary may be inferred from his own words. Immediately after the passage I have already cited, he adds, "*sed perpetui ejus ignes eminus navigantibus, nocte tantum, conspiciuntur. Fumum eorum candidissimum ex Italiæ pariter ac Siciliæ littoribus conspexi.*" It is therefore evident that he saw this volcano only from a distance, and that, consequently, his assertion, that the fiery crater was situated at the summit, is not to be depended on. What he has said of the pumices then thrown out by it, he may have taken on the credit of some of the natives.

natives who gave him that information, and who confounded the scoriaceous lavas with pumices ; or it may in fact be true, since under the scoriæ and lavas of Stromboli, scattered pumices are found, as I have observed above.

From the authorities above adduced it appears, therefore, that the most ancient accounts of the conflagrations of Stromboli, transmitted to us by history, are prior to the Christian era by about 290 years, the date of the reign of Agathocles, the celebrated tyrant of Syracuse. This volcano burned likewise in the times of Augustus and Tiberius, when Diodorus and Strabo flourished. But after this latter period, a long series of ages succeeds, during which, from want of documents, we are ignorant of the state of Stromboli ; and it is not until the seventeenth century, that we again know, with certainty, that it ejected fire ; though it is not improbable that it continued to burn likewise during the times in which we find no mention of it in history : on which supposition,

position, its uninterrupted conflagration, for so great a length of time, must indeed appear astonishing. Yet, though it should have ceased for several ages, we know, from various public testimonies, that its continued eruptions cannot have lasted less than two hundred years.

Here our curiosity may naturally be excited by the question: What are the substances which, without diminution, have nourished, during such a number of years, and still continue to feed, these fires? I do not perceive that there is any reason to suppose them different from those which furnish fuel to the intermitting volcanos, except that their source appears to be inexhaustible. It is believed, with much reason, that sulphur produces and continues volcanos; and wherever these mountains burn, we have indisputable proofs of its presence. Still more effectually to explain these conflagrations, petroleum has, likewise, been called in aid; and, in fact, it has sometimes been found to issue in the neighbourhood

bourhood of a volcano, of which Vesuvius is an example*. The clouds of thick black smoke, which frequently rise into the air from the mouths of volcanos, and the unctuousity and sootiness which are said to be found in the recent scorix, seem likewise to be evident indications of some bituminous sublimate.

That Stromboli contains within its deep gulphs and recesses an immense mine of burning sulphur, we can entertain little doubt, when we consider the streams of smoke, of extraordinary whiteness (a colour which constantly accompanies sulphureous fumes), that rise on the west side of the island, and the smell of sulphur, not only perceptible from them, but from the large cloud of smoke which overhangs the summit of the mountain. The small pieces of that mineral produced near the apertures whence those fumes arise, are likewise another proof.

* Serao, Istoria dell' Incendio del Vesuvio, del 1737.
Bottis, Istoria di varj Incendj del Monte Vesuvio.

But of the presence of petroleum, and its effects, I have never perceived the least sign. Besides that no vein of it is found in the island, nor any ever seen swimming on the sea which surrounds Stromboli, as I was assured by the general testimony of the inhabitants, the smell of this bitumen is no where sensible, though naturally it is very acute. I have frequently visited the sources of petroleum, at Monte Zibio, in the territory of Modena, and I could always perceive the smell of their penetrating vapours, at the distance of several hundred paces, before I reached them. I therefore conclude, that these vapours must have been much more sensible at Stromboli, as they would have been much more active, had petroleum actually burned within its gulph. I have, likewise, examined, with the greatest attention, the scoriz thrown out by the volcano, and while they were very hot; but I never could perceive that they emitted, either from their surface, or within their pores and cavities, the least smell of that bituminous substance, or that they any
where

where exhibited any unctuous humidity. As I knew that the smoke which exhales from burning petroleum is of a blackish hue, I suspected that the thick and dark column of smoke, which arose to the east of the volcano, might be a sign of its presence; but, on a nearer approach, I perceived that its darkness proceeded from aqueous vapours which were mixed with it, and which, by my continuing a short time in it, rendered my clothes damp and wet.

Shall we then affirm that the fires of Stromboli receive no kind of aliment from this bitumen? Notwithstanding the observations I have stated, I would not venture confidently to deduce such a conclusion; since it is possible that the petroleum may burn under the mountain, at so great a depth, that its vapours may not reach to the top, but may be dispersed and consumed by the fire, and the immense mass of liquefied matter, which probably extends from the crater to the lowest roots of the island.

But

But though we should not admit the existence of this oil within the deep recesses of the mountain, I do not perceive but the sulphur alone may be sufficient for the nourishment of the volcano, when its flame is animated by oxygenous gas, the presence of which, in volcanic abysses, seems undeniable, from the substances they contain proper to generate it, when acted on by the fire. The long duration, without intermission, therefore, of these conflagrations, may be very sufficiently explained by the immense quantities of sulphur, or, to speak more properly, sulphures of iron which we must necessarily suppose contained in the bowels of the mountain; a supposition rendered the more probable by the prodigious subterranean accumulations of this mineral which have been discovered in various parts of the globe.

CHAP. XII.

**BASILUZZO, BOTTERO, LISCA-BIANCA,
DATTOLO, PANARIA, SALINE.**

Basiluzzo, in part, formed of granitous lavas—Its sterility—Uninhabited—Bottero and Lisca-Bianca, two rocks, in many places decomposed by acid vapours—Sulphurated hydrogenous gas (hepatic gas) issues from the sea near these rocks, which, still, probably, cover the remains of fire—Dattolo formed of lavas in a great measure decomposed—Panaria formed of granitous lavas—This island fertile and inhabited—Probability that this group of rocks and small islands are the remains of a vast ancient volcano—Saline formed by an accumulation of currents of lavas—Course of these currents to the south of the island—Their various stratification and nature—Some remains of craters on the summit of this island—Result of experiments

ments in which natural granites were exposed to the furnace, to compare them with those which, by the action of subterranean fires, have contributed to the formation of Basiluzzo and Panaria—An extremely strong fire required for their fusion—A fire equally strong required for the re-fusion of these granitous lavas—Consequence which appears naturally to follow from the great violence of the volcanic fires required to produce the granitous lavas of these two islands.

THOUGH this chapter will contain an account of several islands, it will be very short; since several of them are rather rocks than islands, and they have all been so carefully examined by the Commendator Dolomieu that little remains for me to add to his observations. The first five are situated between Lipari and Stromboli, and it is manifest to ocular inspection that they are the work of fire.

Basiluzzo is about two miles in circumference,

ference, and is raised some poles above the surface of the sea. On the south side is a narrow bay, which I entered on the morning of the 7th of October, on my return from Stromboli to Lipari. I went on shore, and, by a winding path, soon reached the summit, which is a plain of no great extent, and the only place capable of cultivation, though it produces only a little corn and pulse. This scanty vegetation is nourished by a thin crust of decomposed lava, under which we soon discover the solid lava, which, in many situations, is granitous, the quartz, felspar, and mica, being very apparent in it; as has been before observed by the excellent French Naturalist above mentioned; and on making the circuit of the island we find that almost all the remainder of it is composed of similar lavas.

Two little cottages which belong to the proprietors of this ungrateful soil are the only buildings here. Near them are some ancient ruins, amongst which I found a piece of red porphyry, spotted with reddish felspars.

feldspars. I at first imagined it a volcanic product, but soon changed my opinion ; since I could not find any specimen of the same stone on the whole island, and because I was convinced, on a more careful examination, that the fragment in question was an ancient Egyptian porphyry, which had been polished by art, and had never been exposed to the action of the fire. I was therefore induced to believe, from the circumstances of the place in which I found it, that it had either made a part of the materials of some of those ruined edifices, or, which seemed more probable, that it had been brought thither by the people who had once inhabited them.

Rabbits are the only animals found in Basiluzzo ; but these had nearly reduced to despair the few inhabitants of the island, by the mischief they did to their corn, till they at last brought against them an enemy capable of following them through their subterranean holes—I mean the cat.

From

From Basiluzzo I proceeded to Bottero and Lifca-Bianca, two rocks abounding in crusts of sulphate of alumine (alum), and for the most part formed of lavas whitened, and so decomposed that they are easily reducible to powder. This decomposition has manifestly been the effect of acid vapours, though of these there is, at present, no sign; except that near these two rocks we meet with a strong smell of sulphurated hydrogenous gas, and, following it where it is most powerful, are led to a shallow part of the sea where a great number of air-bubbles rise with rapidity, and as soon as they reach the surface burst. This gas it is which produces the smell.

The sea could not have been more favourable for the collecting this aëriform fluid; since when I sailed from Lipari to Stromboli it was stormy and ran high, but on my return was perfectly calm. I secured, therefore, a sufficient quantity of it in some flasks, which I had taken with me in my journey through the two Sicilies, in order

to make some experiments on it when I should arrive at Lipari, the result of which I shall here, as it seems the proper place, lay before the reader.

This gas, when a lighted candle was applied to it, rose in flame, but with scarcely any detonation. It took fire slowly, and the flame was of a reddish blue. It was therefore a sulphurated hydrogenous gas, as more evidently appeared from its having deposited some particles of sulphur in the vessel in which it was fired. The little depth of the sea at the place from which this gas issued, and its perfect calmness, enabled me to make another experiment, by letting down, by means of a small cord, precisely on the place from which this gas rose, one of those thermometers, which, in consequence of being included within several wrappers, slowly receive, and lose as slowly, the temperature to which they may be exposed. After having left one of these immersed under the water for three quarters of an hour, I found, on drawing it up, that the mercury had

had risen to 28 ($96\frac{1}{2}$ of Fahrenheit), though in the atmosphere above the surface it only stood at $20\frac{1}{2}$ (69 of Fahrenheit). A hot exhalation therefore arose from that part of the bottom together with the sulphurated hydrogenous gas; an observation which renders it probable that a latent fire still remains there. The depth of the water was eleven feet; and it was evident that the bottom was a continuation of the rock Bottero.

Scarcely a mile from Lisca-Bianca and Bottero, towards the west, a third rock rises above the water, named Dattolo, the formation of which is likewise to be ascribed to lavas, in a great degree decomposed like the former, and some of which have an iron-red colour. M. Dolomieu says, that a spring of boiling water gushes out at the foot of it; but all my endeavours to discover this spring were fruitless. The sailors who managed the boat in which I was, and who were natives of Stromboli, and, from making the passage from their island to Lipari,

several times in a week, must be acquainted with every part of that sea, and all the rocks it contains, assured me that they had never seen nor heard of any such spring. I shall not, however, venture to deny its existence, but am rather willing to believe, that neither they nor I discovered it from want of attention. Supposing its reality, it certainly is a proof that the conflagration under these rocks is not entirely exhausted.

Proceeding still from Stromboli towards Lipari we next arrive at Panaria, which is not a rock but an island, in circuit more than eight miles, though it is but little raised above the sea. The rock of which it is constructed is here, likewise, volcanic granite; but as it is in many places superficially decomposed, and in others mixed with substances very easily decomposable, a rich soil is afforded in various parts of the island, on which olives, and other fruit-trees, cultivated by many families resident here, luxuriantly flourish.

We must therefore ascribe the origin of this group of rocks and islands to submarine conflagrations. But are we to conclude that each of them owes its formation to a particular volcano, or that these rocks and small islands are no other than the remains of a very ancient larger island, in a great degree destroyed by the powerful action of the waves of the sea? M. Dolomieu is of the latter opinion, in support of which he adduces many plausible arguments, conjecturing that this island was the ancient *Euonimos*, the seventh of the Eolian isles, which, according to Strabo, lay on the left, in sailing from Lipari to Sicily, which is exactly the situation of the small islands I have described. I shall not repeat the reasons by which he supports this conjecture, but refer such of my readers as may be desirous of examining them to the author's own work.

Late in the night of the same day I returned to Lipari, where I had my residence, and whence, from time to time, I made ex-

cursions to the other neighbouring islands. As the sea was perfectly calm during the whole of that day, we could make no use of our sails, but were obliged to perform the whole passage by the assistance of our oars. So great a calm in that sea, which is usually tempestuous, is extremely rare ; and, indeed, during my whole continuance among these islands, I did not witness such another day.

In the morning I embarked for Saline, which is so near to Lipari, that, by the aid of a light easterly wind, I arrived there in less than hour. This island derives its name of Saline (or the salt pits) from the muriate of soda (sea salt) which is dug on one part of the shore. It was anciently called *Didyme*, or the twin, from its appearing at a distance bifurcated, though, on a nearer approach, it is found to be trifurcated, as its summit terminates in three points. Among all the Eolian islands, this, after Lipari, is the largest, since it is more than fifteen miles in circuit. From the examination which I made of its shores, and the parts of a moderate

derate elevation, I ascertained that its structure was an accumulation of currents of lavas. Of these M. Dolomieu has examined and described several: I principally fixed my attention on those which descend from the south side of the island to the sea. It is evident that they have flowed from the summit of the mountain, and fallen almost perpendicularly into the sea, after a course of a mile or more. But it is, at the same time, equally evident that these currents have flowed at different periods. In many places they are found with deep fissures, though it is difficult to say, whether these have arisen from the lavas suddenly congealing, and thence contracting and opening in many places, or whether they have been produced by the action of the rain waters or by some other cause. However this may be, these fractures are a kind of anatomic dissections of the lava, which shew that the upper coat of it lies upon another, and that upon a third, below which are many others. It is also to be remarked, that these strata are commonly specifically different from each

other. We must therefore conclude, that as many currents of lava have flowed from the highest part of the mountain, to the south, as there are distinct strata ; and it is probable, that were we able to penetrate to the most internal part of the island, we should find the whole, or almost the whole of it, of a similar formation.

This certainly is the structure of almost all volcanic mountains. Their beginning is but small, and proportionate to the quantity of the first eruption ; but as the succeeding eruptions increase in number and extent, they augment in size and solidity, till in time they acquire considerable dimensions. In this manner, in fact, appears to have been produced the immense bulk of Etna, Vesuvius, the islands of Lipari, and many other burning mountains. I do not, however, deny that there are some which are the offspring of a single eruption, as Monte Nuovo, near Pozzuolo, and Monte Rosso, on the side of Etna.

It

It appears to me superfluous to particularize the different qualities of the lavas, since, as has been observed by M. Dolomieu, they are common to other volcanos. I shall only remark, in general, that I did not find one which can properly be called simple, as they all abound, more or less, with felspars and shoerls, and have for their base the petrosilex, and the horn-stone.

No traces, at present, remain of those volcanic fires which have produced Saline, except the currents of lava, and some vestiges of ancient craters on the summits of the mountain.

When treating of Stromboli, we found that the natural rocks, which, by their fusion, gave birth to the island, were a species of porphyry, having for their basis either the petrosilex or the horn-stone. We have now seen that the rocks to which Saline owes its origin are of the same kind. But the formation of Basiluzzo and Panaria has been different; the rocks which have there been
con-

converted into lava by the action of the fire being granitous; and it seems probable that the spacious volcano, which, it has been conjectured, once arose in the sea between Stromboli and Lipari, and of which, at present, only some small remains exist in Basiluzzo, Dattolo, and Panaria, derived its origin from the same stone.

In pursuance of the plan I have prescribed to myself of subjecting to our common fire some natural rocks similar to those from which the Eolian isles have been formed, I shall here describe the effects produced by the furnace on different specimens of granite; and I must add, likewise, that the difficulty with which, it is well known, granites are fused in our common fires, was to me a considerable inducement to make these experiments.

The furnaces which are worked at Pavia, at a certain season of the year, only fuse common glass, that is, such as is blown into small vessels, and is but little transparent, of a yellowish

a yellowish or greenish colour, and usually full of bubbles ; but at another season they will melt fine crystal glass, manufactured for the same purposes, and which is white, transparent, and much purer. The greater part of the volcanic productions mentioned in this work, as also the analogous natural stones, have melted in the furnace in which common glass is made ; but the specimens of granite have proved more refractory, and in the same degree of heat have only been rendered friable from the enfeebled affinity of their aggregate parts ; or, at the utmost, a few of them only have been found covered with a thin vitreous varnish. I was therefore obliged to have recourse to the furnace in which the crystal glass is elaborated, when the heat was nearly $87\frac{1}{8}$ degrees of Wedgwood's pyrometer, or, according to the observations of Mr. Wedgwood, only $2\frac{1}{2}$ degrees less than the welding heat of iron. The following are the results afforded by several species of granite, after having been continued in this heat during forty-eight hours.

I. Granite

I. Granite of Mount Baveno, in the Milanese. This granite, which forms a great part of the materials of the principal public and private edifices in Milan, Pavia, and other towns in Austrian Lombardy, has for its constituent principles, quartz, mica, and felspar. There are two varieties of it; one in which the felspar is white, and the other in which it is of a more or less deep flesh colour.

The fire changed the mica, and produced a beginning fusion in both the varieties of felspar, which abounded with microscopic bubbles, without however acting as a flux to the quartz, which, calcining, acquired a whiteness, without, however, losing its vitreous nature, and the degree of transparency it possessed. The sharp angles and projections, if they are felspathose, become blunted and round; and the fragments, if there are more than one, adhere in consequence of the slight fusion of the felspar, but they never incorporate into one mass within

within the crucible ; on the contrary, they become extremely friable.

II. Mount Baveno likewise produces a granite which may be considered as a different species from that now described, and which is equally used in buildings. It is schistous, and easily separates into large flakes. The mica, which is of a shining black, instead of being dispersed within it in separate scales, extends in broad leaves, placed one over the other ; and the quartz and felspar are frequently distributed in flakes.

This granite loses its solidity in the fire, without fusion ; but the mica and felspar shew evident signs that they have been softened.

III. Granites of the Italian Apennines.

Though a considerable part of the Alps which surround Italy, abound with these rocks of the first formation, they are very
rare

rare in the Apennines, which are principally formed of calcareous stone, sand stones, and steatites. In the various excursions which I have made to different parts of them, I have rarely found this stone, and never but in very small quantities, and detached pieces, without being able to discover whence they came. In the spring of the year 1790, I collected some of these scattered pieces, in the river Stafora, at the foot of a hill, a few miles from the town of Voghera. They were of three species: the following are the distinguishing properties of the first.

Its constituent principles are four; the quartz, of the colour of water, scattered in small but numerous pieces; the black mica, in few, and extremely minute flakes; the felspar, rather abundant, and of the colour of honey; and very small shoerls, included within the felspar.

The pieces, except that they adhered together,

gether, retained, when they came out of the fire, the same figure they had before, though the felspars were a little, and the shoerls entirely, fused.

The second of these granites, with respect to its component principles, is similar to the common, consisting of mica, felspar, and quartz; but it is one of the hardest and most beautiful that I have seen, and takes a very elegant polish.

In the fire the quartz becomes almost pulverulent, the felspar assumes a slightly enamelled surface, and the fusion of the black mica covers the pieces with a thin coating which has an unctuous appearance.

The third granite has for its component principles, semi-transparent quartz in small and rare grains, and felspar in large and numerous particles.

In the furnace, the quartz becomes friable; but in the felspar, we only perceive signs that it is softened.

IV. In

IV. In Chapter XI. I have mentioned an Egyptian porphyry which was exposed to the fire. I shall now add that this stone, from porphyritic that it was, became, in many places, granitous. In consequence, therefore, of forcible separation, or insensible alteration, the mass of porphyry may be lost, and succeeded by the granite, composed of fhoerls, abundant felspars, and argillaceous particles.

In the furnace, this granite imperfectly fuses into an ebullient scoriaceous enamel.

V. This granite, as it contains sulphure of iron, and red sulphurated oxyde of mercury (cinnabar), merits a particular description. It forms a mountain in the district of Feltre, in the Venetian territory; to the east of which lies the *Valle Alta*, to the west the *Acqua Pezza*, to the south the *Bosco delle Monache*, and to the north *Vallone*. Some years past, this rock was dug into, and perhaps is still; not to employ it in building,

but to extract the mercury with, which it is impregnated, and of which it furnishes fifteen parts out of a hundred. This interesting information I received from Signor Francesco Antonio Tavelli, student of natural history, under whose directions these excavations were undertaken, in the year 1786. He furnished me with several fine specimens of this rock, which I immediately perceived to be granite. Its component parts are quartz, in crystallized grains; felspar, in lamellar, semi-transparent, whitish scales; and steatites. The latter does not form a paste, or common cement, which conglomerates the quartz and felspar, but is distributed in such a manner, that these three constituent parts adhere together solely by the force of attraction. The steatites is soft and schistous, and of a dark green colour. This is the only part of the granite to which the sulphur has penetrated; to free it from which, it is necessary to break it into small pieces. The sulphur, therefore, has sometimes mineralized the mercury, and sometimes the iron. Some parts, however,

of seven or ten lines, and frequently even an inch and a half, or two inches, in thickness, are of a lively red, though the steatites has lost its peculiar texture; and these parts, as they abound most with mercury, are the heaviest. The rest, on the contrary, are lighter, as they contain a less quantity of this metal; and hence, likewise, their colour is of a deeper or paler red. In the midst however of this diversity of tints, the felspar and quartz seem to have been impenetrable by the sulphur, and, in the reddest places, still preserve their natural colours and respective degrees of transparency. But in other parts of the steatites, the sulphur has mineralized the iron, producing sulphure of iron. This is of a brassy yellow, and sufficiently soft to decompose in the air, efflorescing, and emitting sulphate of iron (vitriol of iron). About four years ago, I received from Signor Tavelli at Venice, some pieces containing this sulphate, which I put into a box; and a few months after found them to be broken, and covered with a yellowish efflorescence. When touched

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with

with the point of the tongue, they occasioned a strong astringent taste, from the presence of this sulphate (vitriol), which, in fact, is likewise procured from that rock.

When this granite came out of the furnace, the steatites and the felspar were blended into one porous scoria, but the quartzous grain remained unfused.

VI. The experiments on numbers IV. and V. are, however, less to the purpose, since if we should compare, by the means of our common fires, the granites which are found fused at Basiluzzo and Panaria, the constituent parts of which are felspar, mica, and quartz; and the natural granites; the latter must necessarily be found to consist of the same principles. I have already, as has been seen, made the proof with several, nor did I neglect to do the same with five other species, which I do not describe that I may not tire the reader. I shall only say, in general, that the quartz was always infusible; the mica, in two instances, melted; and the

M 2 felspar,

feldspar, every time, gave signs of a beginning liquefaction; which occasioned the pieces in the crucible to adhere together, but without forming a consolidated whole, as is the effect of complete fusions.

VII. As M. Dolomieu has remarked that the Eolian isles have a part of their base of granite, I endeavoured to discover from what places it might derive its origin; and, after several laborious researches among the mountains of Sicily, concluded that it proceeded from rocks of the same species, extending to the mountains of *Capo di Melazzo*, which are in part formed of granite, and have likewise their direction towards this island.

In my passage from Lipari to Messina (a distance of about sixty miles) I made some stay purposely at this cape, which lies about the mid-way, judging it to be of importance to examine the nature of the place; and I, in fact, found there granite.

Mica,

Mica, sometimes black, and sometimes of a silver colour; blueish, and sometimes milk-white quartz; and reddish or whitish felspar, are the three component parts of this granite, sometimes distributed nearly equally, and sometimes in very unequal portions. Sometimes, though rarely, the mica is hexagonal; and the felspar shews a beginning crystallization.

This granite is not found in strata, but large masses, which form a considerable part of Cape Melazzo and its environs, and in many places extend quite to the sea. Here, likewise, we discover, under the water, the ruins of a very ancient edifice, built of this stone.

As, therefore, it appeared extremely probable that this granite was the same with that of which Panaria and others of the Lipari islands are composed, it was more particularly requisite that the same experiment should be made on it in the furnace, which had been made on the other species;

and since the proportions of its three elementary parts varied in it, I took five varieties, and placed small pieces of each in separate crucibles.

The result was, that the mica became more fragile, the felspar exhibited some signs of fusion, and the quartz lost its transparency and became full of flaws. The pieces, however, all retained their original form.

VIII. In Panaria, and some parts of Basiluzzo, are found pieces of granite, in which the fire appears not to have caused the least alteration ; and yet there is every reason to believe that they have been thrown out of the mouths of volcanos, though they are still in the natural state in which they are found in the bowels of the earth. This granite in its three constituent principles, and the qualities of each of them, extremely resembles that of Melazzo. It likewise resembles it in its resistance to the fire, as only some traces of fusion in the felspars are observable.

IX. Lastly,

IX. Lastly, I made some experiments on certain specimens of granitous lavas, which have formed currents at Panaria and Basiluzzo; but the result was not more successful than with the other granites: they entirely resisted the fire, except that the felspar was in some places thinly covered with a kind of enamel varnish. This was one of the very few lavas which was not fusible in the glass furnace.

These facts sufficiently prove that these granites, such at least as are composed of quartz, felspar, and mica, are infusible in a heat of $87\frac{1}{8}$ degrees of the pyrometer of Wedgewood, though continued in it for forty-eight hours; a heat which, as has been said, is only $2\frac{1}{2}$ degrees below that in which iron begins to fuse, which is at 90 degrees of the same pyrometer. I determined, therefore, to expose these stones to that degree of heat, or even a greater, having recourse to a wind-furnace in which iron is completely melted. In this, in less than an hour, a fusion took place which was perfect

or little less in the felspars, and beginning and sometimes complete in the mica; but the quartz shewed no signs of liquefaction. When, therefore, the quantity of the felspar was greater than that of the two other component parts, the pieces in the crucible formed one single mass, with a smooth surface, either even, concave or convex, in the same manner as in the fusion of lavas. The mass, however, was not homogeneous. The felspar, whatever was its colour, became of a milky whiteness, extremely smooth and shining, and considerably harder. It is remarkable that the mica which, in some granites, was of a silver whiteness, and in others of a gold colour, is changed in consequence of its fusion to a deep black*.

These

* I shall here add a remark which I had intended to make in the introduction to this work, but which will not be improperly placed here. As in these fusions I made use of crucibles of clay, it may be objected to me, that I am not certain whether the substances on which I made my experiments were fusible in themselves, or in consequence of their combination with the clay of the crucible. But I answer, in the first place,

These experiments when compared and considered must lead us to conclude that the fusion of granites requires a very violent heat; and with these experiments likewise agree those made on stones of the same kind by MM. D'Arcet, Gerhard, and Saussure. I have said *in general*, since I do not deny that, in a less intense fire, the fusion of the felspar may be obtained, in some species of granite, which may draw after it that of the quartz*. Though in the almost endless varieties

place, that this combination rarely happened; and that when it did, it was too conspicuous not to be perceived, as the crucible was more or less corroded. Secondly, that I did not form my judgment of the fusibility of the substances I examined, from the parts of them in contact with the crucible, or at a little distance from its sides; but from those near the middle, where, from the distance, this combination could not have place, as the circular mouth of the crucibles I used was two inches in diameter. When, therefore, I speak of the fusion of any product, I consider myself as perfectly certain that the clay of the crucible had no part in it.

* Morveau, in a letter to the Comte de Buffon, writes, that two pieces of different kinds of granite, being placed separately in the crucible, in less than two hours

rieties which I fused and have described in this work, the felspars in general were refractory ; yet they sometimes easily melted in the furnace used at Pavia for the manufacture of common glass, the heat of which, as has been said, is much less than that employed in making the crystal glass. This has been proved in the felspars of the lavas of Ischia, which, whether mechanically united to other substances, or single, completely fuse*. The facility with which some few felspars melt, and the refractoriness of others, I have found to proceed from the different quantity of fîlex they contain combined with other earths, which is small in the former, and very abundant in the latter. If, therefore, a granite which has for its base the felspar contain but a small portion of fîlex, there is no doubt but its fusion may be obtained with a moderate heat. It is, however, melted into a homogeneous glass (Buffon Miner. T. I. in 12.): but he neither specifies the constituent parts of the two granites, nor the degree of heat necessary to fuse them.

* See Chap. V. near the end.

ever,

ever, certain, from the experiments above adduced, that completely to fuse the felspar in the granite of Cape Melazzo, and in the detached pieces of a similar kind found at Panaria and Basiluzzo, as also that which constitutes the basis of the lavas of these two islands, not to mention other species which have been enumerated, a very strong heat is necessary, and equal to that required to melt iron.

— It hence appears to be sufficiently proved that the volcanic fires which have produced Basiluzzo, Panaria, and the other neighbouring islands, must have been extremely violent; the importance of which deduction will more distinctly appear when we come to consider the question relative to the activity of volcanic fires in general.

CHAP. XIII.

VULCANO.

Different parts of this island distinctly visible from the summit of the Monte della Guarnia, in Lipari—Shore of the island entirely formed of volcanic productions—Vulcanello, a small island, once separated from Vulcano, but long since united to it by an eruption—Two singular lavas of Vulcanello—Its crater—Surrounded by sulphureous fumes and hot exhalations—Lumps of sulphur found in the earth through which these fumes pass—Grotto celebrated for a medicinal water which it contains, and other peculiarities—Summit of the mountain scattered over with vitreous lavas, pumices, and glasses—The transition of the pumice into glass distinctly observable—Hot sulphureous exhalations on the side of the mountain, which has the figure of a truncated cone—The bones found there, whitened and decomposed

composed—Other similar fumes higher up the mountain—Subterranean noise heard there; with a shaking of the earth when struck with the foot—Sulphur formerly extracted at Vulcano by the Liparese, and purified on these heights—This profitable labour now abandoned, and why—New sulphur re-produced where it had been dug up—The larger crater of Vulcano situated at the summit of the truncated cone—Descent of the Author into the crater—Its interior described—Subterranean noise heard at the bottom of the crater—Wind which blows at the bottom generated by sulphurated hydrogenous gas—Extreme heat of the bottom—A kind of hill in the middle of it exhaling a quantity of vapours, and incrustated with various minerals—Reverberated sound produced in it by the falling of a stone—Gulph immediately under it in which a strong fire burns—Blueish sulphureous flames seen by night rising from this bottom—A cavern of considerable size hollowed in the sides of the crater, which descends to the bottom—Objects most deserving

ing notice in this cavern—Glasses and pumices of this volcanic bottom decomposed by sulphureous acids—Prismatic or basaltiform lavas, which derive their origin from fire, discovered within it—Erroneous opinion of M. Sage that the decomposition of the lavas, and other volcanic productions, is to be ascribed to the muriatic acid—Demonstrative proof that these decompositions are the effect of sulphureous acid vapours—Incidental notice of another error of that chymist, relative to the Grotta del Cane, near the lake Agnano.

AS from the top of a lofty tower which overlooks a spacious and noble city, we command a perfect view of the latter, its circuit and extent, its lofty and sumptuous palaces, and its numerous edifices; in like manner, from the summit of the Monte della Guardia, one of the highest mountains in the island of Lipari, we contemplate with astonishment the circumference, the massy body, and the various distinct parts of the neighbouring Vulcano.

To

To this mountain I, therefore, repaired, expressly to take a comprehensive view of the island previous to my visiting it; in which, besides the course and inclination of its rocks and cliffs, its craters are clearly perceivable, and it may be distinctly seen that the form of the larger is that of a truncated cone. The white fumes, which ascend from it, are likewise very visible by day, while by night the atmosphere above the crater assumes an obscure redness. Here, too, we may most distinctly perceive the junction of Vulcano to Vulcanello; which latter, as is well known, was anciently an island, separated from Vulcano by a narrow arm of the sea, that has since been filled up with earth by a violent eruption. The new land which has joined the islands may be very clearly seen, and appears to be formed of a sterile sand. The two small havens at its extremities, one of which is called the eastern, and the other the western, are, likewise, distinctly visible.

Such was the anticipated pleasure afforded

me

me by this mountain, which was afterwards still more increased, and accompanied with still greater instruction when I coasted the island in a boat. Its shore is about eleven miles in circuit, and every where presents to the eye the traces of fire, in the remains of streams of lava, enamels, vitrifications, puzolanas, and pumices.

Vulcanello has long made a part of Vulcano, but is still perfectly distinguishable from it by the interposed land. It has the form of a scalene triangle, two sides of which sink abruptly into the sea, and merit examination more than any other parts of the shore. They consist of many strata of lava, several feet high, and piled one above the other. When they flowed, they must certainly have extended farther into the water; but they have been broken, gradually, by the violence of the waves; and their fractures now form a kind of wall of a great height, which descends perpendicularly into the sea. As the water here is shallow, the bottom may be seen scattered over with large

large pieces of these lavas; and the wall, on a near approach, presents to the eye a number of currents of lava, which have flowed at different times, and differ in their colour, component parts, and consistence.

The appearance of these currents of lava, which have flowed one over the other, reminded me of what I had observed several years ago, in the glaciers of Switzerland; where some parts of the snowy coating being broken, the different strata of snow, which had fallen at different times, are distinctly discernible by the difference of the colour.

As the greater part of these lavas differ very little from those of other volcanos, I shall not give a description of any of them except two only, which appear to me not to be common.

The first lies buried in the midst of the

VOL. II.

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others,

others, and would, therefore, only become visible by cutting them away, did not the superincumbent lavas, which are in several places broken, discover it in those fractures. In its superficial parts it is a true enamel, very black, and shining, entirely opaque, which easily crumbles, and in which are incorporated many shoerlaceous and felspathose scales. This enamel contains tumours marked with stripes and large threads, which appear every where in it, but always run in the same direction, which is that of the course of the lava, or from the mountain to the sea. The substance of these stripes and threads is likewise enamel. Their presence and direction sufficiently indicate that the enamel when it flowed and entered the sea was rather of a soft consistence than fluid.

I at first imagined that, as the other contiguous lavas were each of one substance through the whole of their depth, it must be the same with this enamel, as far as it formed

formed a distinct current, as we shall see in the enamels of Lipari; but on breaking some of the larger pieces, I found that this was not the fact. The enamel is only the superficial part, or crust, of a lava, many feet deep, which crust, where it is thinnest, is scarcely more than a line in depth, but where thickest frequently more than two inches. It cannot, however, in any manner be considered as a later product, or as having flowed after the lava and attached itself on it; this crust of enamel is certainly a true continuation of the lava itself, as I have, in my opinion, satisfactorily ascertained by repeated and careful examinations. The enamel, therefore, after having formed this crust of greater or less thickness, suddenly lost its distinctive characters, and changed into a lava of a reddish grey colour, dry, rough to the touch, earthy, emitting an argillaceous odour, and having for its base the hornstone, without losing its scales of shoerls and feltspars. We must hence conclude that the current was more affected by the fire on its surface than in its internal

parts; for I know no other mode of explaining this phenomenon.

From this enamel and lava, when exposed to the furnace, results a similar enamel; that is to say, one of a dark grey colour, very hard and compact; with a fusion of the shoerls, and a semi-fusion of the feltspars.

Another product with a hornstone base, of a very singular quality, and which I do not remember to have seen any where else in my volcanic travels, is found on one of the sides of Vulcanello that descend perpendicularly into the sea, and, having been broken in different places by the violence of the waves, present upon the shore, and within the water, a large heap of fragments of a globular form. At the first view it might be taken for a tufa. It is rather light than heavy, may be crumbled to powder between the finger and thumb, imbibes water, with which it is in a few moments saturated, with a kind of hissing sound, and emits an argillaceous

laceous odour. We know that similar properties are usually found in volcanic tufas: but these have an earthy grain, whereas the present substance rather inclines to the vitreous. Besides, when the shoerls it contains, which are innumerable, are examined, they are found to be distributed equally, as they usually are in lavas—a distribution never met with in tufas, in which the shoerls that are sometimes found in them are scattered confusedly and at random. Hence, as they are extraneous bodies, they are easily detached from the tufaceous mass; but this is not the case with the product in question, which, consequently, we must consider as a true lava.

But to what are we to attribute its softness? Perhaps it has been considerably changed on the surface by sulphureous-acid vapours, by length of time, or some other unknown cause. Such, at least, was the first idea which presented itself to my mind, but which I found inadequate, both because in that place no sulphureous fumes exhale, nor are

there any indications that any ever have exhaled ; and, because, having procured this lava to be dug up from the depth of five feet, I found it, there, extremely soft as well as at the surface. I am rather of opinion that this lava is the result of the combined effect of fire and water ; as examples are not wanting, in volcanized countries, of similar combinations. I mean that the lava, while flowing, was met and penetrated by a stream of water, that had gushed from some aperture of the volcano, by which it was suddenly cooled, and lost that coherence which is usually the property of lavas. I found this opinion on several observations. I perceive that the lava has a number of cracks and fissures, such as are usual in stoney substances which, while in a state of fusion, have come into contact with water. I observe that the shoerls, which in other lavas have the hardness of glass, are in this so friable that they may be scratched with the nail ; and as such appearances are not usually the effects of volcanic fire alone, I know not to what to ascribe them but to the

the action of water; since vitreous substances in a state of fusion are affected in precisely the same manner by contact with that fluid.

The ebullient though hard enamel, which is the result of this lava in the furnace, is of a fine deep black; the shoerls are melted; and it is worthy remark that in it we discover some small flakes of white felspar which before were not discernible in the lava on account of its cinereous colour.

The two lavas I have described, as likewise others of which I have omitted the description on account of their being common, and which together form the two sides of Vulcanello, appear by their direction all to have proceeded from the crater, which is about two hundred paces distant from the sea; and which still retains its natural figure of an inverted tunnel, except that the bottom is covered to some height by earth which has been carried down by the rains from the internal sides. These

sides are formed of pulverized clay and sand, and are marked with deep furrows caused by the descent of the rain water. The circumference of the bottom of the crater, judging by the eye, cannot at the utmost be more than seventy, but that of the top⁺ is about the sixth of a mile. Its depth is scarcely eighty feet. The crater on the outside is surrounded with rocks of lava, probably the consequences of an eruption. It is evident that, as more earth is continually falling into it, it must at last be filled up; and as the external sides of it are ill-formed, there is no doubt but that one day every trace of it must be lost. We hence perceive how many volcanized countries may appear, and in fact do appear, to be destitute of craters; these not having been able to resist the injuries of time.

Here was it that I began to perceive the indications of the subterranean burning furnace; for round the crater of Vulcanello many streams of a white smoke arise; and it is only necessary to strike the ground with the
foot

foot to produce more. They are very hot, as are likewise the apertures through which they issue, and which, in the night, from time to time, emit a feeble flame. The ground, which fumes at the surface, within, contains crusts of sulphur, which are most abundant in the places where the fumes exhale most copiously. But we shall soon have occasion to treat more at length of the sulphur of this island.

From Vulcanello I proceeded to a grotto which has obtained some celebrity on account of a mineral water it contains, and is at the distance of about a mile from the western haven. To reach this water, it is necessary to descend into the grotto, the entrance of which is so narrow, that you are forced to stoop very much, and almost creep on the hands and knees. It is a moderately large cavern, incrustated round with sulphate of alumine (alum), muriate of ammoniac (sal-ammoniac), and sulphur. These minerals are found to be very warm, as likewise is the atmospheric air in this place,

on account of the heat of which, the strong sulphureous smell, and the difficulty of respiration, it is impossible to remain long in the grotto, which you are obliged to leave from time to time, to breathe fresh air. At the bottom is a small pool of very warm water, which is esteemed by the Liparese to be efficacious in many disorders. The Abbate Gaetano Trovatini, a learned physician of Lipari, has published an analysis of this water*. I shall not therefore enter into a minute account of it, which would be superfluous, but shall only remark that, besides the sulphureous odour it emits, it contains abundantly the muriate of ammoniac (sal-ammoniac), and still more of the muriate of soda (sea-salt); which latter salt I imagine it derives from a communication with the neighbouring sea, with which it appeared to me on a level. Though its temperature is not higher than 80 degrees, it continually appears to boil, from the great number of air bubbles that rise from the bottom to the surface, which they

* *Dissertazione chimico-fisica sull' analisi dell' acqua minerale dell' Isola di Vulcano. Napoli 1786.*

entirely

entirely cover. This water, in fact, so much abounds with this æriform fluid (which I found to be carbonic acid gas), that when shaken in the slightest manner a prodigious quantity of bubbles arise. I likewise observed, relative to the same object, that if a stone be let fall into this water, as it sinks, a vast quantity of these bubbles will ascend, and will continue to rush to the surface several minutes after it has reached the bottom. The continual emission of so much carbonic acid, which doubtless concurs to render the air in the cavern unfit for respiration, produces within the grotto a confused noise, which may be heard likewise without.

M. Dolomieu, in his account of this subterraneous place, observes that a considerable quantity of smoke issued from it. This, when I was there, I could not perceive; either because it had opened to itself another passage, or that the cause by which it was produced has ceased: changes not unfrequent in volcanic countries.

This

This cavern is represented in Plate IV. A A is the narrow entrance, B B B the top and sides, and C C C the small pool, full of air bubbles.

To this place, the ascent of the island is gradual; but the remainder of the way which leads to the highest crater of Vulcano is extremely rugged and difficult; as it lies over a long mile of continued heaps of lavas, vitrifications, and pumices. The fatigue, however, is alleviated by the pleasure which the instructive examination of these productions affords. Some of the vitrifications found among the lavas clearly manifest, that they were originally pumices, which, by a more intense heat, have passed into the nature of complete glass. The breaking of some of them proves this beyond the possibility of a doubt. We then find one part a common pumice; I mean resembling threads of silk, light, extremely friable, floating on water, and of a very white colour. Another part we find to be vitreous, of a different texture, less filamentous,

tous, less light, less white, and less friable. Still farther, begin to appear long veins or threads of glass, which continually increase in thickness; and, at last, in another part of the piece, multiply and consolidate into a mass completely glass. This glass is semi-transparent, of a colour between grey and black, and so hard as to give sparks with steel.

It is worthy of remark that some of the black shoerls, and white felspars, incorporated in the pumice, are preserved entire in this glass.

The furnace melts neither of these; though it completely fuses the glass, which is changed into an extremely porous enamel.

Mixed with these curious combinations of glass and pumice are found true glasses, and true pumices, as also a variety of lavas, which, having lost, in a considerable degree, the texture of their primitive rocks, have

have acquired a vitreous appearance. They are extremely compact, give sparks with steel, are of a blackish or dark blue colour, and are not wanting in felspars and shoerls. Some of them will move the magnetic needle at the distance of three quarters of a line. One of them has become a volcanic breccia, as it contains within it fragments of other lavas which it enveloped while in a state of fusion. These fragments are of a coarse grain, and a spongy texture, and when minutely examined are found to derive their origin from the hornstone, while that of the including lava is from the petrosilex. The same difference continues even in the furnace, the fragments becoming scoriaceous, and the lava a semitransparent glass.

These glasses, pumices, and lavas, do not form currents, but are found in large masses; and it is probable that they were thrown out of the mouth of the volcano in the same state in which we now see them.

As

As we proceed up this difficult ascent, we perceive, near the top of the truncated cone, five or six streams of smoke, approaching which we find that each of them issues from an aperture incrusted round with small crystals of sulphur. If a stick be thrust into them, and drawn out again soon after, it will appear black, and smoke. The earth is here extremely hot, every stone is decomposed, and of a white colour; and if new apertures are made with a staff (which may easily be done from the great softness of the ground), new fumes will immediately issue similar to the other; that is to say, white, very offensive from their sulphureous smell, and extremely hot.

Above these fumes there is a plain, of no great extent, which one is, at first, afraid to venture on, from the subterranean noise heard there, and from the shaking of the ground when struck with the foot. Here we find other sulphureous fumes, besides ammoniacal vapours, which, attaching to
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the decomposed lavas, generate thin crusts of that salt.

On this plain it was, that, formerly, stood the furnaces in which the sulphur of Vulcano was purified. But this useful labour has been long since abandoned; and even prohibited, from the supposition that the vapours arising from the purgation of the sulphur were prejudicial to the plantations of vines in Lipari. A few years ago, indeed, it was again resumed, by the special permission of his Sicilian Majesty; but was soon again given up, not because any fear was then entertained that the vines would be injured, which the more judicious of the natives of Lipari are now convinced is a vulgar error, since they sustain no damage from the smoke of the crater of Vulcano itself, though that is beyond all comparison more in quantity than that produced by the purification of the sulphur: nor was it abandoned because the quantity of sulphur obtained was too little to repay the
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the trouble and expence, as the vein is very rich and even inexhaustible ; for wherever the ground about the craters of Vulcano and Vulcanello is but slightly turned, fine clods of sulphur are found ; which are larger and more numerous the deeper the earth is dug into. My own observations have in this particular sufficiently confirmed the testimony of the people of Lipari : as I was convinced, in my different visits to the island, that in the very places from which the sulphur had been extracted, after a short time it is re-produced.

The real cause why the inhabitants of Lipari no longer continued this work was, that the ground, which on the surface is more or less warm, grows hotter the deeper it is dug into, and, at the depth of five or six feet, becomes so hot as to be almost insupportable ; to which is to be added the offensive stench of the sulphureous fumes that issue in great abundance from these excavations. If this mineral was once extracted here to great advantage, as we are

assured by history, it seems certain that these difficulties could not then exist.

Continuing my journey towards the south from these forsaken furnaces, and having mounted a short but steep ascent, a second, but a much more spacious plain opened before me, which was every where sandy, except that a few erratic lavas were thinly scattered over it. Beyond it rose a considerable eminence, which when I had ascended, the noblest spectacle Vulcano can offer presented itself to my view, I mean its crater. Except that of Etna, I know none more capacious and majestic. It exceeds a mile in circuit, the mouth is oval, and its greatest diameter is from the south-east to the west. This mountain externally has the form of a direct cone, and its crater that of a cone inverted. The height of the internal sides from the bottom to the top is more than a quarter of a mile. From the top, the bottom may be seen, which is flat, and from many places in it exhale streams of smoke,

that rise above the crater, and emit a sulphureous odour which may be perceived at a considerable distance.

After having made the circuit of the upper circumference of the crater, I became desirous to enter it, and descend to the bottom, to examine the internal parts; the southern side, which is not very steep, appearing to invite to such an examination. I was not willing however to undertake such an adventure alone, but wished for some one to accompany me, who might serve me as a guide, and, I may likewise add, who might keep up my courage. But my wishes were vain. The four sailors who had worked the boat which brought me to the island, and had gone with me to the edges of the crater, when they found I entertained thoughts of going down into it, positively refused to follow me, alledging the evident danger to which I should be exposed, and adducing the example of I know not what traveller, who, a few years ago, having descended into this deep gulph,

paid for his temerity by never coming out again. All my entreaties, therefore, and all offers of reward were fruitless; and I was obliged to return to Lipari without having been able to gratify my wish. These sailors were natives of Lipari, nor could I find any of their countrymen who would hazard accompanying me in making this experiment. So great is the dread they are inspired with by this volcano, proceeding, probably, from the fame of its ancient terrors, and also from some recent eruption, of which we shall hereafter have occasion to speak.

A resolute Calabrian, who had been banished to Lipari for some crime committed at Naples, was the only one, who, with the permission of the Marchese Chiavelli, the governor of that city, and the promise of a large reward, could be induced to go down with me into the crater. We descended on the 13th of September 1788. I have already said, that the sides towards the south-east are not very steep, and on this side

side we therefore safely reached the bottom, where I proceeded to make such observations as I thought of most importance. I here perceived, more distinctly than I could above, that the crater was a hollow cone reversed, but truncated by the bottom on which I stood. The sides, except in that part where we descended, are every where inaccessible. As they are covered with sand, they are marked with deep furrows which are the effect of rains.

The bottom on which we stood, may be about somewhat more than a third of a mile in circumference. It is covered with sand, like the sides, and in form an oval. I soon perceived that it could not be walked over without danger, and that it was necessary to use the greatest circumspection in examining it. I have already mentioned the subterranean noise heard on approaching the crater of Vulcano. Here it may be said to be a hundred times louder. Under this bottom we seem to hear a river running, or rather a conflict of agitated

waves which meet, and impétuously clafh together. The ground, likewise, in some places, cleaves in cracks, fiffures and apertures, from which hissing founds iffue refembling thofe produced by the bellows of a furnace. I therefore thought there was every reason to conclude, that thefe founds are occafioned by an elastic gas which iffues through thofe fiffures; and was afterwards perfectly convinced of the truth of this fuppofition by the following facts. If the hand be approached to any of thefe clefts or apertures, a ftrong impreffion is felt of an extremely fubtle invifible fluid; and, if a lighted candle be applied to them, it will, it is true, be frequently extinguifhed by the impetus of the fluid, but fometimes it will fet fire to the fluid itfelf, producing a flame of a blueifh-red colour which lafts for feveral minutes. The fetid odour which is then perceived convinced me that it is a fulphurated hydrogenous gas.

The ground at the bottom was fo hot that it burned my feet; and I fhould not long have

have been able to endure its heat, had I not, from time to time, got on some large pieces of lava which were not so hot. From the extreme heat, and the strong stench of sulphur emitted by every part of the bottom, so as to render respiration somewhat difficult, I could scarcely go round it, and it was quite impossible to cross it near the middle; at least it would have been very dangerous to have attempted it. About the middle of this bottom arose a circular eminence, of about forty-five feet in diameter, from every part of which a dense vapour sublimes, and the surface is covered with crusts of sulphate of iron (vitriol of iron), sulphate of alumine (alum), muriate of ammoniac (sal-ammoniac), and sulphur; as I found by collecting and examining some fragments of these crusts at the edges of the eminence. Its heat is insufferable; and on pressing the edge with my feet I perceived it shake very sensibly, as if I had trod on a floor of boards which yielded and sprung up again under me. On letting fall a large piece of lava from the height of my

body, a subterraneous echoing sound was heard, which continued some seconds; and this happened on whatever part of the bottom the piece of lava was let fall, but the sound was loudest near the eminence in the middle. These circumstances sufficiently proved that, while on this bottom, I walked over a gulph from which I was only separated by a flooring of volcanic matters of inconsiderable thickness, and that in this gulph the fires of the volcano still continued active, of which the subterraneous noise, the fumes, vapours, and extreme heat were evident indications.

Another proof, in confirmation of this, is furnished by an observation I made at other times by night, for I was not contented with a single visit. This is, that, when it was dark, several blueish flames might be seen to rise from the bottom, to the height of half a foot, a foot, and sometimes higher. It is to be remarked, that those which ascended from the eminence before mentioned, were more numerous
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and rose higher; and that besides those which issued spontaneously, it was in my power to produce new ones, by making small excavations in the ground. The strong disgusting sulphureous odour which all these flames emitted convinced me, that they were the effect of the sulphur itself, which still continued slowly to burn below, in a state of fusion.

But the object most curious and most interesting to a naturalist is a grotto, on the west side of this bottom, which, from the variety of things it contains, merits to be described at some length. It is an excavation in the sides of the crater a hundred and ten feet in height, two hundred and fifty in breadth, and ends at the bottom in a pit thirty feet in circumference. From this pit continually arises a column of whitish smoke, which alone equals in quantity, or perhaps exceeds, all the fumes that arise from the bottom of the crater. Its strong and suffocating sulphureous stench, and its extreme heat, prevent any near approach.

proach. A part of this smoke, meeting with no obstacle, ascends in a direct line, and rises above the mouth of the crater; but another part of it, soon after it has issued from the bottom, is obstructed by some stones which jut out from the sides of the grotto; and attaching to the lower surface of these, the sulphur which had been sublimed with the smoke falls down again, and collecting, in several places, forms stalactites of sulphur; some in the shape of inverted cones, and others cylindrical. The largest are three feet in length and two inches thick. On striking several of them with a stick, I found that this sulphur is extremely pure. Sometimes it is of a flesh colour, but more frequently of a fine yellow; brilliant on the surface, and semi-transparent where the stalactites are thinner; which properties also give value to the other sulphur that is dug round the crater of Vulcano, and exists likewise at its bottom; as I observed that, in the fissures from which the sulphureous fumes issue, it is found consolidated in fragments of various sizes.

sizes. The stalactical alone, however, has the cylindrical or conical form, which is produced by the fusion of its parts, and their descent by gravity; whereas that which is generated under ground is usually found in amorphous masses, and sometimes in strangely irregular configurations.

It seems scarcely necessary that I should mention the manner in which sulphur must be continually formed in this island; since it is well known that this mineral is not entirely consumed in conflagration, but that a great part of it is sublimed, unchanged in its substance, which again deposits itself, sometimes crystallized, and sometimes amorphous, on any bodies with which it may meet. As it is therefore perpetually burning in the subterraneous furnace of Vulcano, it continually produces those numerous white fumes which arise from various places, and those lumps, cylinders, and cones of sulphur which I have before mentioned. The sulphur which is so frequently found
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in other burning mountains is generated in the same manner.

From the pit within the cavern, whence the cloud of smoke continually issued, a louder noise was heard, than at any other part of the bottom ; and on throwing stones into it, I could not perceive that they struck against any obstacle, as they gave no sound, but a kind of hissing one occasioned by the resistance of the air in their fall. It appears probable, that this cavern has an immediate communication with the subjacent furnace of the volcano,

From one of the sides of the cavern, at the height of eight feet from the bottom on which I stood, issues a small spring of mineral water, which leaves on the different lavas depositions which well merit to be examined. If we suppose this water to proceed from the sea, it can only be by evaporation, as the level of the sea is very much lower than the place whence it issues. It
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may possibly derive its origin from rains, which penetrating to the interior parts of the mountain, and accumulating in some cavity, have here found a free outlet, depositing in different places the heterogeneous substances with which they became impregnated in their passage.

Where this water flows, we find, in the first place, hanging stalactites of sulphate of alumine, some of which are of the thickness of ten inches, and a foot and a half in length. On breaking them, they are found to be a congeries of barks, or rinds, similar to the coats of onions, as stalactites in fact usually are.

Secondly, these stalactites are not always composed entirely of sulphate of alumine, but are mixed with muriate of ammoniac.

Thirdly, the sulphate of alumine, in some places, instead of being stalactical, is crystallized in beautiful stellated groups consisting of very fine silver silky threads.

Fourthly,

Fourthly, between the stones where this water issues, we frequently find stalactites of sulphate of iron.

Lastly, on the ground where this water falls, we find a number of hollows filled with a kind of thick pulpy matter, which is no other than a confused mixture of all these salts, which, from the partial evaporation of the water, begin to assume a body and consistence.

To enable the reader to form a more distinct idea of the crater of Vulcano, of which I have described the principal objects, I have given a representation of it in Plate V. in which the letters A, B, C, D, mark the upper oval circumference; F F, G G, the inclined sides, to the south-east, by which I descended to the bottom of the crater; H H, a part of that bottom from which arise a quantity of fumes, and where I am represented standing; L L, other fumes met with before we reach the crater; M, N, O, P, the extensive sandy plain which, to the

the south of the island, lies under the truncated cone on the top of which is the crater; Q, R, S, another smaller crater, of which I shall speak in the following chapter.

The sides of the crater of Vulcano, and the oval plain which forms its bottom, are covered with sand, as has been already observed. This sand, however, cannot properly be so called, since it is a mixture of fragments and small particles of pumices, lavas, and glass; among which are found, principally where the sulphureous fumes are strongest, entire and large pieces of vitrifications, pumices, and lavas, which well deserve the careful and accurate examination of the observing naturalist.

We will begin with the former of these substances. At the bottom of the crater of Vulcano we find a glass which is of a lead-colour, and not unlike another kind found in ascending the cone of Vulcano. Many pieces which lie without the fumes are preserved unchanged; but many of those with-
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in them exhibit different degrees of alteration. The first and slightest degree is a thin cinereous coating, which invests the glass, and is less hard than the internal part. The sulphureous acids, therefore, have only acted on the surface of these pieces. In others they have penetrated deeper, as appears by the greater thickness of this tender and half pulverous coating. Some are so changed, that nothing remains of the glass but a small central nucleus; while others have entirely lost even this nucleus, and the whole piece, from being of a lead-colour, hard, semi-transparent, and smooth, is become of an ash colour, soft, opaque, and yielding to the touch. In these, therefore, the glass has undergone a complete decomposition.

It had been discovered, long before I wrote on the subject of volcanos, that sulphureous acids would decompose lavas; but I believe I am the first who has observed a similar decomposition in volcanic glass.

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In the same place we find pieces, of various sizes, of a more perfect, harder, and extremely black glass; which, likewise, where the sulphureous acids abound, has undergone the same changes.

A number of particles of sulphur are frequently attached to the surface of both these glasses, and some are also found within their substance, where small fissures have opened to them an entrance.

We will now say a word of the pumices. They do not differ from those we meet with on the declivity which leads to the summit of the mountain, and which, we observed, with an intense heat, changed into glass. Yet these likewise suffered more or less alteration from the above-mentioned acids. In some their fibrous texture was reduced to a kind of pulverulent earth, which scarcely retained a single original filament. In others this texture was preserved, yet they might be easily reduced to powder by the finger.

It now remains to treat briefly of certain prismatic or basaltiform lavas, likewise found in this volcanic bottom. In the first place, where the sulphureous acids are strongest, we find scattered pieces, superficially decomposed, which seem to have been broken off from larger columns. They have a pentagonal prismatic figure, with unequal sides and angles; and the larger pieces are about nine inches in length by eight in thickness. Their base is a petrosilex, which, from its having suffered fusion, is of a very singular kind.

In the course of this work I have frequently had occasion to speak of lavas with a petrosiliceous base, and shall certainly have occasion to speak of them again. They are all too strongly characterized for their base to be confounded with other stones. They, however, carry in them the marks of fire, in a certain fibrous appearance which they have, and which originates from a diminution of the affinity of aggregation when in a state of fluidity. The petrosilex of which I

now

now speak, on the contrary, exhibits no signs of injury from the fire, though it is certain that it has suffered fusion. It is of that kind which is somewhat scaly; has a grain and hardness little different from that of flint; is transparent at the edges, of a shelly fracture, and of a livid ash-colour. When pulverized it becomes white. The pieces, when struck together, sound like flint. This stone contains a few irregular shoerls, of a black colour, and but little lustre.

After a continuance of forty-eight hours in a furnace of sufficient heat to liquefy the fine crystal glass, this prismatic lava with difficulty melts. To obtain a complete fusion, it is necessary to have recourse to a stronger heat; with which view I used a wind-furnace. After thirteen minutes, its volume increased almost threefold, from the diminished force of aggregation; and then the lava acquired a snowy whiteness. Continuing the same fire, its dimensions contracted, and it at length produced a white

enamel, moderately hard, and interspersed with microscopic bubbles.

The first time I ventured to explore the bottom of the crater of Vulcano, I only found some fragments of this prismatic lava: but when I repeated my visits, and had divested myself of the fear I at first felt, and more carefully examined this dreary bottom, I was enabled to complete my discovery by ascertaining the origin of these prismatic, or, as some may choose to call them, these basaltiform lavas. For, raising my eyes to that part of the sides of the crater which was over my head, and facing the north-east, I perceived a large stratum of lava, almost perpendicular, divided lengthwise into complete prisms, some of which were continued with the lava and made one body with it; while others were in a great measure detached from it, so that, striking them with a long and heavy pole, I beat three of them down. I then clearly perceived that the pieces I mentioned above were fragments of entire prisms, since the
external

external characters of both were precisely the same.

Each of these prisms exceeded a foot in length; but, as far as could be judged by the eye, other prisms adhering to the mass, which I could not reach, were of much larger dimensions. The lava which contained them stretched to the ground, but did not appear of great extent, as its upper parts and sides were covered with a thick sand.

The production of these basaltiform lavas, which, from their situation, and their forming a whole with the lava, no one can doubt derive their origin from fire, may, I conceive, be thus explained. In former times an effervescence took place in the melted lava in the crater, which, after having swelled, and perhaps overflowed its edges, slowly sunk in the cavity of the crater, from the diminution of the fire, and the impellent elastic substances, while a portion of the lava attaching itself to the internal sides, and hastily cooled by the atmospheric air,

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contracted,

contracted, and divided into regular parts, such as are the forms of the hexagon prisms above mentioned. Their perfect preservation and freshness are a clear proof that they are not of very ancient date.

I shall conclude this chapter with a few observations relative to the decompositions which I remarked in various productions both within and around the crater of Vulcano. These decompositions I have said were produced by sulphureous acid exhalations. I have asserted the same of some decomposed lavas in the vicinity of the volcano of Stromboli, as also of a great number of those of which Solfatara is principally formed *. And in general, when the question is of lavas, the alteration of which consists in being softened and rendered mild and saponaceous like argilla, and in a whitening of the parts, I perceive that the greater number of volcanists agree with me in sentiment. I find, however, that M. Sage is of a different opinion, maintaining that such

* See Chap. II. and Chap. XI.

decom-

decompositions are generally to be ascribed to the action of the muriatic acid, which is the cause of the greater part of the alterations that take place in the products of volcanic eruptions. He attempts to demonstrate this by the experiment of a black lava which, in his laboratory, became white and equally decomposed with those found in some volcanos, by keeping it in digestion in concentrated muriatic acid. Other similar experiments likewise confirm him in this opinion *.

That the muriatic acid is capable of producing decompositions in various volcanic productions analogous to those we frequently observe in the materials of burning mountains, I am the more easily persuaded, since, having repeated the experiment of the French chemist, I have found it accurate. I placed in two vessels, filled with concentrated muriatic acid, some fragments of two different lavas, the one from Etna, the other from Vesuvius, both of a colour approaching

* *Elemens de Mineralogie.*

black, of the horn stone base, and containing a number of black shoerls. Having closely stopped the vessels, I left them for a month; at the end of which time the lavas were become of a yellowish cinereous colour; and, having washed away the muriatic acid with which they were impregnated with distilled water, they lost the yellowish tincture, and became entirely of the cinereous colour. Some of them had likewise become in some degree friable, though before they were hard. The decomposition had in fact penetrated more or less to their internal parts, though the shoerls remained unaltered both in texture and colour.

This author however admits, in another place, that the sulphuric acid is likewise capable of producing the same effect, which I also experimentally ascertained on the two lavas above mentioned *. It is, in like

* Notwithstanding that, at the end of a month, the muriatic and sulphuric acids had been equally efficacious

like manner, known, that the sulphuric acid possesses an equal strength when the sulphur is caused to burn very slowly. It remains, therefore to determine which of these two acids, the muriatic or the sulphuric, is the real cause of the decomposition and whitening which is frequently observed in products of volcanos, at least of those which I have most attentively examined, Stromboli and Vulcano. And though

cious in producing alteration in the two lavas, yet, after a longer time, the muriatic appeared to be more powerful than the sulphuric. At the end of seven months and a half, on examining the lavas which had remained in the same situation in the two acids, I found that the muriatic acid had decomposed them more than the sulphuric. Besides that they had acquired a whiteness almost equal to that of snow, they had become very light, and extremely friable and spongy, from the corrosion of the acids. The shoerls remained black, but had lost their vitreous appearance. Both these lavas, likewise, contained a number of felspars, which suffered less than the shoerls, as they always retained their natural changing lustre. But the sulphuric acid only produced in these lavas a cinereous colour, a less degree of friability and lightness than was caused by the other acid; and the black shoerls did

though I shall, in another part of the present work, produce direct proofs, that some lavas, enamels, and volcanic glasses, sometimes give reception to the muriatic acid, yet, certainly, the decompositions in question are not to be attributed to this acid, but to the sulphureous. The odour of these acids is too different for them to be confounded; and both at Stromboli and Vulcano, in the places where these decomposed products are found, enveloped in

did not lose any of their glassy brilliancy. This acid was concentrated equally with the muriatic. Instead of the colour and limpidness of water, it was become turbid and dark. The muriatic had acquired a beautiful golden yellow. I must add, that having poured some fresh sulphuric acid on the old, the decomposition and whitening of the lavas, after some time, was not inferior to that produced by the muriatic acid. I found a remarkable difference between the alteration observable in lavas in the vicinity of volcanos, and that which is effected by the sulphuric and muriatic acids, since the volcanic alterations are sometimes accompanied by an unctuous smoothness I never observed in the two lavas exposed to the action of the above-mentioned acids, which on the contrary had become rough and scabrous.

white

white fumes, I very sensibly perceived the acrid, pungent, and suffocating fœtor of the sulphur, as also the sharp taste, if a particle of the fumes, by accident, entered my mouth. I likewise particularly remarked, at Vulcano, that where the sulphureous fumes were most dense, and left crusts of sulphur attached to the bodies they touched, these bodies, whether lavas, pumices, or glasses, suffered greater alteration than others; and, in some of them, the decomposition had penetrated to the depth of two feet.

An experiment which I shall now relate offers a new and indisputable proof of what I have here asserted. At Vulcano, I left a piece of extremely black lava, which had for its base shoerl in the mass, and was one of the firmest and hardest I could find, in an aperture from which issued a great quantity of very hot fumes; and, after it had continued there two-and-thirty days, I observed, that, in its upper part, it remained untouched; its black colour, only, having become

become somewhat lighter ; but on the sides, and still more on the lower part, where the impression made by the sulphureous fumes had been greater and more active, it was become white, with a sensible softening of the solid parts near the surface.

Had M. Sage, instead of deciding, while shut up in his laboratory, that the muriatic acid is the cause of the alterations which take place in volcanic countries, himself visited those countries, he would have thought differently ; and had he in the course of such a journey entered the Grotta del Cane near Pozzuolo, the expression would never have escaped him, that *this perpetual mephitis is produced by the volatile marine acid* *.

* See Chap. III.

CH A P. XIV.

VULCANO CONTINUED.

Among the few naturalists who have made a voyage to the Eolian isles, M. de Luc the only one who has entered the crater of Vulcano—Summary of the observations made by him there, in 1757, compared with those of the Author—Similarities and differences between the local circumstances of the crater at that time and those of the present crater—Observations made by the Commendator Dolomieu from the summit of the crater in 1781—Remarkable changes which have, since that time, taken place in the crater—Commotion of Vulcano in 1786—No eruption of lava from the crater has happened within the memory of any of the natives of Lipari now living—The phænomena of this volcano habitually observed by them—Visits made to this crater by Father Bartoli, in 1646, and Professor

Jeffor d'Orville in 1727—Interior conflagration through the whole of the crater at the first period—Not one but two craters at the second—Hill which at that time rose from the bottom of one of the two craters—Vulcano then in its greatest agitation—Some obscure memory still retained by some aged natives of Lipari of a double crater at the summit of Vulcano—Sterility of this island on the side next Lipari, though there is no want of vegetation on the opposite side—Porphyritic lavas in this part of the island, but greatly decomposed—Small crater on the side of Vulcano described for the first time—The fumes of Vulcano observed by some of the Liparese as signs of good or bad weather, in the same manner as the inhabitants of Stromboli consult their burning mountain—Observations published by a native of Lipari, on the diversity of the fumes, and internal commotions of Vulcano, betokening, according to him, what winds will blow—Observations of the Author not agreeable to those of the Liparese—The fires of Vulcano

more

more powerful at that time than now, if the accounts given by that writer may be relied on—Ancient accounts of the conflagrations of Vulcano—Number and size of its craters—Its different eruptions—This burning mountain, in a certain degree, comparable to Vesuvius and Etna—Prognostics of the winds which may be expected to blow from the symptoms of the volcano very ancient; and perhaps deserve equal credit with the modern.

AMONG the very few naturalists who have made a voyage to the islands of Lipari, M. W. de Luc is the only one, to my knowledge, who has entered the crater of Vulcano. This he did on the 30th of March, 1757, as appears from an account of the observations he made there, published in the second volume of the Travels of M. de Luc, a summary of which account I shall here present to the reader, as we shall thus be enabled to compare the local circumstances which existed at that time, with

with those observed by me in one of the most superb and spacious gulphs at this day to be found among burning mountains.

He relates that he reached the bottom of the crater, by a narrow passage, which afforded him entrance, but with great risk of being suffocated by the dense sulphureous fumes that enveloped him ; in consequence of which danger he was obliged to enter alone, the guide who had conducted him to the summit of the crater, and who was a native of Lipari, having refused to follow him. He found the bottom very rugged and uneven, of an oval form, with several apertures, from which issued sulphureous vapours, and from some a strong wind. The sound of his feet as he walked on it was very sensible.

The longest diameter of the oval appeared to him to be about eight or nine hundred paces, and the shorter between five and six hundred. The height of the
sides

sides of the crater he imagined might be about one hundred and fifty, or, towards the east and the south, two hundred feet. At the bottom they were nearly perpendicular, and were composed entirely of volcanic materials.

A column of smoke, of fifteen or eighteen feet in diameter, issued from a cavern which above lost itself in one of the highest sides of the crater, and below ended in a kind of tunnel, or rather abyss, of about sixty paces in circuit ; and the fumes on issuing out of that abyss roared like the vapour of boiling water, when it escapes from a vessel not closely covered. Several pieces of scorizæ being thrown into it were no longer heard when they had passed beyond the tunnel.

Another object likewise strongly attracted the attention of M. de Luc: this was an aperture, five or six inches in diameter, which terminated in a small tunnel about two feet and a half deep, from which the air

rushed with as much violence as from the bellows of a forge. He threw into it great pieces of lava, which enlarging the opening, caused the wind to issue with less force, but the small pieces that were detached from the aperture were driven outwards by it. The fragments of lava which fell within, produced the same effect as the scoriæ thrown into the tunnel of the cavern. As these observations convinced him of the extreme thinness of the floor or shell on which he stood, he thought it advisable to quit this perilous gulph, and direct his researches to objects less dangerous.

He then remarked that the sulphureous vapours of the volcano had here a communication with the sea, which was in many places of a yellow colour, and in others emitted fumes; and that in the places where the fumes rose its heat was intolerable; so that the fish that happened to approach that shore soon died, and the beach, where a few inches above the level of the sea warm veins of

water burst out, was scattered over with dead fish.

Such is the substance of the observations of M. de Luc, made about thirty-one years before mine. On comparing the one with the other, it will appear, that if the internal parts of the crater of Vulcano have suffered some changes since that time, they are still essentially the same. At present (at least, at the time when I was there, I might have said, at present) the sides of the crater are in most parts nearly perpendicular, the circumference of the bottom is an oval, from a number of fissures and apertures sulphureous fumes issue, and from others streams of wind with a hissing sound. The bottom likewise shews evidently that it is a dangerous and a false bottom, by shaking and founding when walked over. The cavern excavated in the sides of the crater, and described by the above-cited traveller, also still exists, and from it a cloud of sulphureous fumes continues to exhale; and had not M. de Luc been fearful of prosecuting his researches, it

is more than probable that he would have found it abounding with sulphur and various salts, as it is at present.

The differences, therefore, between the state of the crater at the time it was entered by M. de Luc and at present, are reduced to these; first, that the narrow passage by which he reached the bottom now no longer exists; but that, on the other hand, the sides on the south-east are become less steep, and afford a way to descend into that gulph: secondly, that the height of the crater is now much greater than it was then, as I found it to exceed a quarter of a mile, whereas when M. de Luc was there it was not more than two hundred feet: lastly, that the furnace below the bottom burns much more violently at present, as may be inferred from the intense and almost intolerable heat I felt when I was there, which circumstance, had it existed when M. de Luc made his observations, he certainly would not have failed to have mentioned.

I do

I do not mean to say by this that the subterranean conflagration of the island is now more active or energetic; since it appears that the extreme heat, though not then felt within the crater, manifested itself without, and even in the sea itself, which, as has been observed, smoked in several places near the shore, and was so hot that the fish all died; circumstances which did not exist when I visited the island.

M. Dolomieu, who was there seven years before me, could not go down into the crater, because the narrow passage by which M. de Luc entered no longer existed, and the sides were too steep to admit of any descent. The volcanic mouth, however, was then in the same situation, was large, of an oval form, and emitted, in a great number of places, sulphureous-acid and suffocating fumes.

Yet within this short interval, very considerable changes have taken place. The depth of the crater, as far as a judgement

could be formed by the eye, was then about a mile, the larger diameter of its mouth was half a mile, and that of its bottom about fifty paces. Whence it appears that the bottom, since that time, must have been greatly raised, and likewise have become narrower; while the mouth has been considerably enlarged. From the edge of the crater, he threw into it large stones, which, when they reached the bottom, he perceived sank in some fluid, that could not be aqueous, since it must have been soon evaporated by the excessive heat, but which he judged to be melted sulphur; as he in fact saw that substance trickle down the sides against which it had sublimed. With a good telescope he could discover at the bottom two small pools, which he supposed to be full of the same combustible matter. He likewise, observed that the sulphureous fumes which in the day time appeared white, were by night resplendent but placid flames, that rose above the mountain, and diffused their light to some distance.

blues

When

When I made my observations at the bottom of the crater, though the sulphur flowed in many parts of the cavern, as I have already said, yet it did not stagnate in small pools or pits at the bottom; nor did the sulphureous flames arise by night more than some feet from the bottom.

The changes which have taken place in the internal parts of this volcano, since it was visited by the French naturalist, have probably originated from some later eruption; since it is to that cause that changes of any moment in volcanic craters are usually to be attributed. And in fact, according to the unanimous testimony of the inhabitants of Lipari, it suffered a very violent commotion in the month of March 1786. After subterraneous thunders and roarings, which were heard over all the islands, and which in Vulcano were accompanied with frequent concussions and violent shocks, the crater threw out a prodigious quantity of sand mixed with immense volumes of smoke and fire. This eruption

continued fifteen days ; and so great was the quantity of sand ejected, that the circumjacent places were entirely covered with it to a considerable height ; and, at a small distance from the crater, to the east, there is still an eminence, of a conical form, half a mile in circumference, consisting wholly of this pulverised substance, and, as I was assured, entirely produced at this time. The aperture that must then have been made in the bottom of the crater to discharge such a quantity of matter, and the accumulations of that matter in various places, must necessarily have caused great changes around and within the crater ; one of which, without doubt, is the declivity produced in the southern sides, in consequence of which it is now possible to descend to the bottom of the gulph ; for we find that this long descent is entirely composed of sand.

No lava flowed in this eruption, at least not over the edges of the crater. With respect to the lava of a vitreous nature which is found on the surface on the north-

ern side of the mountain, and of which we have already spoken, M. Dolomieu observed that it existed when he was there, and he tells us that it was thrown out, in large masses, in an eruption in the year 1775: an assertion of the truth of which he should have produced unquestionable documents; for, according to the accounts I received from the natives of Lipari, no eruption of lava has happened in the memory of any persons now living in the island, nor do they seem to have a tradition of any. Clouds more or less frequent or thick, sometimes black and sometimes of a white colour, and emitting a stench of sulphur; subterraneous thunders and concussions, which often shake the whole mountain; flames which rise to a greater or less height from the bottom and sides of the volcanic gulph; the possibility of entering this gulph at one time, and the impossibility of such entrance at another; ejections, at different times, of ignited stones, pieces of vitreous substances, sand, and ashes; these are phenomena

nomena with which the people of Lipari have been long acquainted.

I must here add the observations of two other men of science, relative to the crater of Vulcano; Father Bartoli, and M. d'Orville. The former visited the island in 1646, and relates that it contained a deep gulph, entirely in a state of conflagration within, and, in a small degree, to be compared to Etna; and that from its mouth a copious smoke continually exhaled*.

When M. d'Orville visited Vulcano, in 1727, it had two distinct craters, each of which was at the summit of an eminence. From the first crater, which was situated to the south, and which was about a mile and a half in circuit, besides flame and smoke, ignited stones were ejected; and its roaring was not less than that of the loudest thunder. From the bottom of this gulph rose

* Simboli trasportati al Morale.

a small

a small hill, about two hundred feet lower than the top of the crater, and from this hill, which was entirely covered with sulphur and dirty corroded stones, fiery vapours exhaled in every part. M. d'Orville had, however, scarcely reached the edge of this burning furnace when he was obliged precipitately to retire.

The second crater lay towards the north part of the island. Its conflagrations were more frequent and ardent; and its ejections of stones mixed with ashes and an extremely black smoke were almost continual. M. d'Orville further relates that the noise of this volcanic island was heard many miles; and was so loud at Lipari that he could not sleep the whole night that he remained there*.

If we consider, for a moment, these two accounts, we shall perceive, from the first, that when Father Bartoli visited Vulcano,

* Jacobi Philippi d'Orville Sicula.

the conflagration in its crater was much more vigorous than when I was there; and from the second, that in the time of D'Orville it was in a state of complete eruption. But the most remarkable circumstances are the double burning crater, and the bifurcation of the mountain of Vulcano; whereas, at present, there is but one crater, and the summit of the mountain is single, which summit contains the crater, resembling in figure a truncated cone. The hill which rose to a certain height from the bottom of one of the two craters, still exists, though it is not peculiar to this volcanic mouth, since the same kind of hill has at times been observed in Etna *, and likewise in Vesuvius †.

When I was at Lipari, as I had read D'Orville's account, I made enquiries of some of the oldest people in the island relative to this double burning crater, and I found some few of them who retained an imperfect recollection of it. But from that

* See Chap. VIII.

† Bottis, Istoria di Vesuvio.

time to this there has been only one crater, and I am not certain whether the present be that which the above-cited author describes as on the south side of the island, or that which he mentions as on the north.

The side of the island which looks towards Lipari is entirely barren, and does not produce any kind of vegetable; but this is not the case with the other sides that front the south and the west, and which are partly covered with holms and oaks, besides quantities of broom and other shrubs. It is obvious to suppose that those parts of the island which afford so much nourishment for plants have been more subject to decompositions than that which remains barren. The substances of which they are composed, are lavas become soft to a certain depth, and affording reception and nutriment to plants. This decomposition is not to be attributed to sulphureous acids; for it is not distinguished by a white or any other colour; but originates from the humid elements, and other causes in the atmosphere.

sphere. I caused several of these lavas to be broken away with hammers and pickaxes, quite to the internal part, to which the causes producing change could not penetrate; and there I found them retain all their usual solidity and freshness. In general they are porphyritic, with a petrosiliceous base, and contain felspathose crystallizations. They descend from the summit of the mountain, on the southern side, with a steep fall till they reach the sea. Mixed with the lavas are found large pieces of glass and enamel, which I shall not here describe, as they do not differ from those of Lipari, of which I shall speak in their place.

Such are the observations I made in four different visits to this island, to which I shall add another relative to a smaller crater, different from that of Vulcanello, and which has not, to my knowledge, been noticed by any other traveller. It lies about half way up the mountain, to the east of the way I took to reach the summit. Its form could
not

not more distinctly characterize it as a real crater, since it is precisely that of a tunnel, wide above and narrowing below. Its mouth is about three hundred feet in circuit, and its bottom about eighty. A full quarter of this bottom is filled up with earth carried by the rain down the sides, which are in consequence marked with long furrows. Hence it appears, that, in process of time, this crater will be entirely filled up with earth, like that of Vulcanello, and no trace of it remain (See Plate V. Q. R. S.).

In the same manner as many of the sailors of Stromboli, before they put to sea, are accustomed to consult the fumes and eruptions of their burning mountain; the mariners of Lipari believe the changes of the winds and weather may be foretold by observing Vulcano. Instructed, they say, by long experience, they are able to predict, twenty-four hours before any change, whether the weather will be fair or tempestuous, and from what point the wind will blow. In a work entitled *Traffs by Sicilian*

Sicilian Authors *, printed at Palermo in 1761, there is a *Physico-mathematical Discourse on the manner in which the variations of the winds may be foretold, twenty-four hours before they happen, by the different qualities and effects of the fumes of Vulcano*, by Signor Don Salvatore Paparcuri of Messina †. In this essay we find an extract from a number of observations made on Vulcano between the years 1730 and 1740, and communicated to the author by Don Ignazio Rossi, a native of Lipari. This extract I shall here present to my readers.

“ The change of weather and winds is
 “ presignified by Mount Vulcano twenty-
 “ four hours before it takes place, by a
 “ louder than usual noise, resembling dis-
 “ tant thunder ; and if we carefully observe
 “ the smoke which then issues in a greater

* Opuscoli di Autori Siciliani.

† Discorso Fisico-matematico sopra la variazione de' venti pronosticata ventiquattro ore prima dalle varie e diverse qualità ed effetti de' fumi di Vulcano, del Sig. Don Salvatore Paparcuri, Messinese.

“ quantity

" quantity than usual, we may likewise dis-
 " cover what kind of wind will succeed,
 " which may be predicted from the greater
 " or less density of the smoke, and its more
 " or less dark colour, which is occasioned
 " by the quality and quantity of the dust
 " that rises in the smoke, and renders it
 " sometimes of an ash-grey colour, some-
 " times perfectly white, sometimes of a co-
 " lour approaching to black, and sometimes
 " entirely black.

" The following are the observations I
 " have made on this subject. When the
 " wind is about to change to the sirocco
 " or south-east, or the east-south-east, or
 " south-south-east, the smoke rises so dense
 " and black, in so great a quantity and to
 " such a height, and afterwards dissipates in
 " so black a dust as to strike the beholder
 " with a kind of awe; and at the same time
 " so loud a roaring is heard, frequently ac-
 " companied with a shaking of the earth, as
 " to inspire with dread even those long ac-
 " customed to these roarings and shocks. But

“ when the wind is on the point of chan-
 “ ging to the north-north-east or north-
 “ north-west, the smoke rises more slowly,
 “ is less dense, and entirely white; and when
 “ it is dissipated, the dust which falls is ex-
 “ tremely white. No such loud noise is
 “ then heard, nor any shock felt; at least I
 “ observed none, nor can the oldest inhabit-
 “ ants of this island remember to have felt
 “ any. When it is about to change to the
 “ east or east-north-east, an explosion is
 “ heard in the body of the mountain, which
 “ soon after throws out a little smoke of
 “ a grey colour, of which colour are likewise
 “ the ashes that fall when the cloud is dis-
 “ persed. The mountain in the mean
 “ time explodes and roars so violently at in-
 “ tervals, that we frequently dread the shock
 “ of an earthquake. Lastly, previous to a
 “ change of the wind to the west, the west-
 “ south-west, or west-north-west, vast vo-
 “ lumes of smoke arise, of a dark ash-grey,
 “ approaching the colour of lead, and so
 “ thick that when they disperse they occa-
 “ sion a continued shower of ashes.”

On

On these observations of the Liparese meteorologist, Signor Paparcuri proceeds to philosophize, whether pertinently or not I shall not enquire.

I should think myself justly to incur the imputation of rashness, should I venture absolutely to deny these facts, without having sufficient reasons so to do; especially as they are so precise, so circumstantial, and said to have been observed upon the spot. It, besides, does not appear credible that the Abbate Roffi would have published these observations, had they been merely the fabrications of his invention, in a place where he was liable to be disgraced by the contradiction of all his countrymen. I must however say, with philosophic candour, that during my stay of several weeks at Lipari, where I continually had Vulcano before my eyes, the principal winds mentioned in this extract blew, and particularly the south-east, the west, and the south-west; but I never observed, either before they began, or while they continued to blow, any

shakings of the earth, or roarings, lofty columns of smoke, or showers of ashes. Once only, when a violent south-west wind was on the decline, the column of smoke which issued from the cavern of Vulcano increased prodigiously, and, from the resistance of the agitated atmospheric air, made some spiry windings ; but when it had risen some poles above the upper edge of the crater, it began to grow thinner, and soon after entirely vanished. Though the wind ceased to blow, this prodigious cloud of smoke still continued to rise for several hours. I must add, that I once remarked the smoke of Vulcano to be extremely thin, and little in quantity, when a strong west wind blew ; and that twice, when the air was perfectly calm, I observed the smoke extremely copious and rising to a great height. To conclude, after carefully noticing, day by day, every change that took place in the phenomena exhibited by Vulcano, during my stay in its vicinity, I could perceive none which afforded support to these famous prognostics. I likewise enquired of the sailors of Lipari ;
and

and frequently brought them to confess that the fact did not accord with their assertions. But, besides that they did not agree among themselves, they endeavoured to evade conviction by all those excuses and pretexts which I have observed sea-faring people never to want, to support their particular prejudices relative to the signs of good or bad weather; in consequence of which, they sometimes become the victims of their own credulity by suffering shipwreck.

I am not, however, so positive as to deny the whole of these observations. To know with certainty whether any direct relations exist between the various symptoms of Vulcano and the changes of the atmosphere, it would be necessary to reside for some years in that island, a place truly wild and desolate; and he who, like Empedocles at Etna, should go to erect his dwelling there, in order to observe the changes of the mountain, would have no other companions than the rabbits which make their burrows on the southern side of the island.

Disregarding, however, at present, the pretended relations, observed by Signor Roffi, between Vulcano and the winds; if the accounts of the eruptions which then from time to time issued from its crater may be relied on, we must own that, at that period, the convulsions of this mountain were much more violent and frequent than they are at present: a fact which accords with the observations of M. d'Orville and Father Bartoli.

Before I conclude my remarks on Vulcano, two things remain for me to notice, agreeably to the plan I have followed relatively to the other Eolian isles. First, to specify the results obtained by our common fires in those kinds of rock which, liquefied by subterranean conflagrations, have given birth to the island; and, secondly, to mention the notices left us by the ancient writers relative to Vulcano. The former object of enquiry has been sufficiently discussed, while treating of Stromboli, where we have detailed the changes undergone in the
furnace

furnace by porphyritic rocks ; since, as has been already shewn, rocks of a similar kind have furnished the materials of which Vulcano is composed. We have therefore only to treat of the latter of these subjects.

We are indebted to Thucydides for the first account we have of this island. He relates in his history, that, in his time, Vulcano threw out a considerable flame by night, and smoke by day *.

Aristotle, in his Treatise concerning meteors, describes an ancient eruption of Vulcano, a part of which swelled, and rose, with great noise, into a hill ; which bursting, a violent wind issued forth, together with fire, and so great a quantity of ashes as entirely to cover the neighbouring city of Lipari, and extend to several of the towns of Italy. This eruption was still visible in his time †.

* Την νυκτα φαινεται πυρ αναδιδουσα ('Ιερα) πολυ, και την ημεραν καπνον.

† Εν 'Ιερα εξανωδει τι της γης, και ανηκει οιον λοφωδης ογκος μετα ψοφου. τελος δε ραγενης, εξηλθε πνευμα πολυ, και τον κεφαλον και την τεφραν ανηγενε, και τηνε Λιπαραιων πολιν, εσαν 8 πορρω πασαν κατετιφρωσε, και εις ενιας των εν Ιταλια πολεων ηλθε. Lib. II. cap. 8.

The interesting observations of Polybius, relative to the number, size, and figure of the craters of Vulcano, are likewise particularly deserving our notice. In his time, there were three; two tolerably well preserved, and one, in part, fallen in. The mouth of the larger, which was round, was about five stadia, or five-eighths of an Italian mile, in circuit. This crater, towards the bottom, grew gradually less, till, at last, it was only fifty feet in diameter; this part was one stadium above the level of the sea. The form of the other two craters was the same*.

Such is the account of Polybius, as quoted by Strabo, who himself tells us of three openings, or craters, at Vulcano, from which flames issued and ignited matters were thrown out, that filled up a part of the sea of considerable extent †.

From

* Πολύβιος δὲ τῶν τριῶν κρατῆρων τὸν μὲν κατεβύρηνειναι φησὶν ἐκ μερὸς, τὴς δὲ συμμενεῖν, τοῦ δὲ μέγιστον τὸ χεῖλος εἶναι, περίφερές οὖν, πέντε σταδίων· κατ' ὀλίγον δὲ συναγροῦσθαι εἰς ὃ ποδῶν διάμετρον, καθ' ἣ βάθος εἶναι τὸ μέχρι θαλάσσης σταδίων. Strab. lib. VI.

† Ἐχει δὲ ἀναπνοὰς τρεῖς, ὡς αὖ ἐν τριῶν κρατῆρων. ἐν
 3011. +

From the two latter passages we learn, therefore, that, anciently, there were in Vulcano three burning mouths, or, more properly, craters; and that one of them was very large. Are we to conclude that this larger crater was the same that at present exists, and which, since that time, may have increased its dimensions? This may possibly be the truth; and it may, perhaps, be equally so, that, of the three craters mentioned by Polybius and Strabo, two still remained in the time of D'Orville, who found a double burning crater at Vulcano, though at present there is only one; the other two no longer appearing, either because they have fallen in, or been filled with earth by the rains, or, possibly, have been covered by subsequent ejections.

From the text of Strabo it may be inferred, that, in his time, Vulcano ejected lava, since the burning matter thrown out

δε τε μεγίστη καὶ μύδρος αἱ φλογες ἀναφέρουσιν, οἱ προσπεσχυμασιν
 ἡδὲ πολὺ μέρος τε πορῶ. Strab. Lib. VI.

filled

filled up a part of the sea of considerable extent.

Callias, in his Life of Agathocles Tyrant of Syracuse, relates, that on a lofty eminence of Vulcano there were two craters, one of which was three stadia in circumference, casting a great light to a vast distance; and that from this mouth burning stones, of a prodigious size, were thrown out with so great a noise that it might be heard to the distance of five hundred stadia *.

If, therefore, we believe the testimony of Diodorus and Fazello, who, as natives of Sicily, have the best claim to our attention, we have already seen, when treating of Stromboli, that the former asserts, that both

* Ιστορει. Καλλίας, εν δεκάτῳ των περι Αγαθοκλεα, λεγων εἶναι και λοφον ὑψηλον, εφ' ο κρατηρες εἰσι δυο, ων ο ἑτερος εἰς την περιμετρον τρισταδιος, εξ ο πολυ φερεται φεγγος, ωγε επι πολυν τοπον διηκειν φωτισμον. επεὶτα εκ τε χασματος αναφερονται διαπυροι λιθοι απλετομεγεθεις και τηλικουτος βρομος γινεται, ωγε επι πεντακοσια σταδια ακουσθαι τον ηχον. Scholiast. in Apollon. Argonaut. Lib. III.

that

that island and Vulcano threw out sands and burning stones ; and we learn from the latter, that Vulcano was in a continual state of conflagration ; and that from its gulph, which lay in the middle of the island, a cloud of thick smoke continually issued, while, through the fissures of the stones, and narrow apertures, a pale flame arose in the midst of the dark cloud *.

Cluverius likewise affirms, that from the neighbouring shore of Sicily he had himself observed by night a similar fire amid the dark smoke †.

And here it is proper, with Cluverius, to correct a mistake of Fazello, who, relying

* *Hæc (Vulcani Insula) in medio mari aquis circumfusa perpetuo ardet. Enimvero ex voragine, quæ in medio patet, jugiter ingentem fumi nebulam hodie eructat. Intus vero per juncturas lapidum, et cancellos, angustosque meatus exurens, simul, et pallens ignis inter ipsam fumosam caliginem emittitur. Histor. Lib. I.*

† *Hujusmodi inter fumosam caliginem pallentem ignem egomet nocte e proximo littore Siculo despexi.—Ubi sup.*

on the authority of some superficial writer, has been induced to believe that the island of Vulcano emerged from the sea in the year of Rome 550, without reflecting that, two hundred years before that period, it is mentioned by Thucydides, and that Aristotle, about a century after him, had described one of its eruptions. The mistake has been occasioned by the origin of Vulcanello, which about this time arose out of the water. Pliny has remarked that when this island was thrown up, a great number of fish were found dead, and caused the death of those who ate of them.

The same Fazello relates, that Vulcano was separated from Vulcanello by a narrow channel of the sea, in which ships might lie with safety; and that this strait was open in his time, but afterwards filled up by new eruptions of Vulcano*.

This brief statement of facts recorded by history,

* Vulcanellus tenuissimio Euripo a Vulcania (Insula) recedit

history, when compared with the observations of Bartoli, D'Orville, De Luc, Dolomieu, and myself, clearly proves that this island is a volcano which may be compared to Vesuvius or Etna, with respect to the changes in its craters, the variety of its eruptions, and its longer or shorter intervals of repose; except that, from the want of aliment for its fires, its ejections are less frequent and less copious.

From the authorities above adduced, we perceive that the fires of this mountain are very ancient, since they burned in the age when Thucydides flourished, or 475 years before the Christian æra. This island was then called *Hiera* (Ἱέρα) or the *sacred* isle, as being sacred to Vulcan; for the inhabitants of the neighbouring islands, as Thucydides informs us, perceiving it continually to flame by night, and smoke by day,

recedit Euripus ad ætatem usque meam pervius,
ac fida navigiis statio, nunc, interjecta ex Vulcaniæ
caminis cinerum ac lapidum mole, præclusus est.
Ubi sup.

believed it was the residence and forge of that god *. It is however extremely probable that these volcanic conflagrations are much more ancient than this period; as is the island where they are produced, which no doubt derived its origin from fire, though its formation is concealed amid the darkness of the most remote ages.

The accounts here given of the present state of Vulcano, clearly shew the mistake of Sir William Hamilton, who compares it to Solfatara near Naples; a mistake occasioned by his not having visited the island.

We have spoken above, of the opinion of many of the natives of Lipari, that it is possible to foretell with certainty, what winds will blow, from the different appearances of the smoke of Vulcano. I find that the ancients, likewise, boasted the knowledge of the same prognostics. They inform us, that before a south-wind blew, the island of

* Νομίζουσι δε οἱ ἐνεὶν ἄνθρωποι, ἐν τῇ Ἰέρᾳ ὡς ὁ Ἥφαιστος χαλκνεύει. Thucyd. ubi sup.

Vulcano was enveloped in a dark cloud, so that Sicily could not be seen; and that when a north-wind was to be expected, a pure flame rose high above the crater, and the roarings were more violent; while a kind of I know not what middle symptoms preceded the zephyr or west-wind. The various sounds of the explosions, likewise, and the different places where the eruptions began, the flames, and the smoke, were all prognostics of the wind which should blow after the third day. Such is the account of Polybius, who has been copied by all the writers who have succeeded him*.

These prognostics, however, which the Greek historian, probably, received from the mariners, accord but little with those of

* Έαν μὲν ἔν νότος μέλλῃ πλεῖν, ἀχλὺν οὐμχλωδὴ καλαχέεισθαι κυκλῶ φησὶ τῆς νησίδος, ὥστε μὴδὲ τὴν Σικελίαν ἀπὸ τῆς λεχθέντος φαινεσθαι. ὅταν δὲ βορέας, φλογὸς καθαράς ἀπὸ τῆς λεχθέντος κρατῆρος εἰς ὕψος ἐξαιρεσθαι, καὶ βρομῆς ἐκπτεῖσθαι μείζους. Τὸν δὲ ζεφύρον μέσσην τινα εἶναι ταξίν. ἐκ τῆς δὲ τῆς διαφορᾶς τῶν βρομῶν, καὶ ἐκ τῆς ποθεν ἀρχεται τὰ ἀναφύσσηματα, καὶ αἱ φλογες, καὶ αἱ λῆγνυες, προσημεινεσθαι καὶ τοὺς εἰς ἡμέραν τρίτον πάλιν μέλλοντα ἀνεμὸν πλεῖν. Polyb. ap. Strab. Lib. VI.

Signor

Signor Roffi above cited, and still less with the phenomena observable in Vulcano at present; either because such indicatory signs can no longer take place, now that the volcano is in a comparative state of tranquillity; or because these boasted predictions originated more in exaggeration and credulity than the faithful testimony of the senses.

C H A P. XV.

LIPARI.

PART THE FIRST.

OBSERVATIONS MADE ROUND THE
SHORES OF THE ISLAND.

Unavoidable delays in making the circuit of the island—The city of Lipari and its harbour—Immense rock of lava and glass on which the castle of Lipari is founded—Reasons for believing that the internal part of this rock is a true glass—Other proofs of the ancient existence of fire in that place, derived from the pumices of the same rock—Our common fire acts on volcanic glasses differently from the subterranean fires—Other observations made within the harbour—Porphyritic lava of a beautiful red found in its vicinity—The author leaves the harbour, and makes the circuit of the island, proceeding towards

the North—The enormous breaches made by the sea in the shores of the Eolian islands extremely favourable to the discovery of volcanic products—Another red porphyritic lava—Extraordinary course of another lava—The Campo Bianco (White Field), so called from the white pumices of which it is an entire mountain—Their different species described in detail—Analysis of these and other kinds of pumices in the humid way—Discussion of the different opinions relative to this kind of volcanic products—The Monte della Castagna composed of vitrifications and enamels—Properties of these—Capillary vitrifications—Others which may be considered as in a state of transition from pumice to glass—Not probable that the glass passes into pumice, as some have believed—Resemblance and difference of these two substances—Enumeration of some other kinds of glasses, one of which greatly resembles what is called the Iceland agate, or gallinaceous stone of Peru—Glassy lavas of the Monte della Castagna—This mountain and Campo Bianco,

Bianco, with their environs, form a vitrified mass eight miles in circuit—This vitrification more extensive in ancient times—No characteristic sign of the existence of the ancient volcanos on the sides of this mountain—Indubitable proofs, however, that some of the above-mentioned vitreous substances have flowed, and others been thrown up, from volcanic gulphs—Felspars and petrosilex commonly the base of these vitrifications—Question, whether the vitreous parts, incorporated with or continued through the different lavas, owe their origin to a more vehement action of the fire, or to their being more easily vitrifiable—Singular phenomenon relative to this subject—Universal sterility of this extensive vitrified tract—Uncertainty of the rule which estimates the dates of lavas from their being more or less converted into vegetable earth—Multiplicity of lavas decomposed by sulphureous acids, and variously coloured by the oxyde of iron, found beyond the Monte della Castagna—Decompositions of other lavas, occasioned by the

same acids, and other enamels and pumices found on the shores of the island—Extremely minute shoerls, and beautiful quartzose crystals, and chalcedonies, originating from filtration, in some decomposed lavas—Two large rocks in the narrow channel which divides Lipari from Vulcano—This channel in ancient times must have been narrower than at present—Conjecture that it once did not exist, and, consequently, that these two islands formed but one—Figure of the Monte della Guardia seen from the sea—Its roots of lavas, pumices, and vitrifications—Prodigious quantity of vitreous eruptions which compose this mountain.

THIS island, from its extent, the city which renders it illustrious, the number of its inhabitants, its commerce and agriculture, claims pre-eminence above all the others by which it is surrounded, and which from it derive the name of the Lipari islands. Nor is it less important in the estimation of the naturalist, from the quantity, variety and
unusual

unusual beauty of the volcanic products it contains. M. Dolomieu, during the four days he remained here, gathered as ample a harvest as within so short a time could be expected from the most discerning and indefatigable lithologist; but it is easy to conceive that he must still leave much to be discovered in an island nineteen miles in circuit. During the eighteen days that I remained there, I may say that the sickle was never out of my hand; yet I will freely confess that I left behind me many a handful, which I would willingly have gathered, had this volcanic island been less distant from my home.

For the sake of order in my account of the observations I made in this island, I shall first state those which occurred to me in making its circuit, and examining its shores; and next, those I made in its interior, and in ascending its mountains. My remarks will thus, naturally, be divided into two parts.

PART THE FIRST.

*Observations made round the shores of
Lipari.*

IN making this circuit, that I might perform it completely, I employed more time than I had imagined it could require. Besides the time necessary for remaining with the boat at a little distance from the shore to observe the different courses taken by the volcanic matters, in their way to the sea; when liquefied by the power of the fire; besides that consumed in landing to examine these matters more nearly, and in breaking them to pieces with suitable instruments, that I might collect and preserve them; lastly, besides the time requisite to ascend, or rather to climb up, steep rocks, cliffs, and precipices, which rose from the waves, at the termination of the course of the eruptions; I was not a little delayed by the obstacles which continually opposed the execution of my design. How often, when I attempted to prosecute my intended circuit while the sea was

was calm and smooth as the most placid lake, have I been obliged to desist, and return with my boat, by a wind suddenly rising, either contrary, or blowing in upon the land, so as to expose me to the danger of being driven upon the shore, and shipwrecked on the rocks! Frequently, though the sea was sufficiently calm for a considerable distance, yet, where the coast broke off, or sunk in, I found it running high, from the remains of a storm that had not long ceased, or, as it is termed, an old sea, which my boat was unable to encounter without great danger. Every one who is acquainted with the sea that surrounds the Eolian isles, knows how liable it is to sudden tempests. -

The city of Lipari extends along the shore in the form of an amphitheatre. Behind it rise a chain of mountains; and in front is its harbour, formed by the hollowing in of the sea, which here divides the shore*. I omit to mention another very

* See Plate VI.

small harbour to the south, only fit for the reception of such vessels as may be drawn up on shore.

I began my researches in the harbour itself, under the castle of the city, which is erected on an immense rock of lava, that rises perpendicularly from the water, and is entirely destitute of all vegetation except a few stalks of the Indian fig *, which grow in its fissures †.

This lava has for its base felspar, is of a fine and compact grain, of a scaly fracture, dry to the touch, and gives sparks, like flint, with steel. It is of a cinereous colour, in many places approaching to that of lead. It is full of an immense quantity of small extraneous bodies, which would be with difficulty distinguished from the substance of the lava on account of their resemblance in colour, were they not little globes. This lava is

* Cactus Opuntia Linn.

† See Plate VII.

joined to large masses of glass, which form a whole with it, without any divisions or separations in the middle. It therefore is the same lava, which in some places retains its nature, and in others is transmuted to glass. This glass, in some parts, contains the small extraneous bodies before mentioned, but in others it is pure glass. In general it is extremely compact, of a dull black colour, and fractures rather in irregular pieces than in waving streaks, as is usual with glass. It has besides a kind of unctuousity to the touch, and even apparent to the eye, which is not observable in any other of the most perfect volcanic glasses. Like the lava, it gives sparks with steel; but the lava is entirely opaque, whereas the glass, in the angles and thinner edges, has a considerable degree of transparency. It only appears opaque where it contains the minute globes, which are particles of the lava. Though the lava in the fractures has not the lustre of the glass of which it is a continuation; yet, when cut and polished, it is not in the least inferior to it in that respect. I possess

sefs several pieces, cut and polished, which are half glass and half lava, and of which the different colours form an excellent contrast.

An observation which I made relative to this kind of glass appears to me too important to be omitted.

If we take a piece of this glass, six or seven feet in length, and four or five thick, and attentively examine it, we shall discover that it is marked with small grey veins parallel to each other, which give it the appearance of being divided into strata or flakes; and if the point of a large pickaxe be struck by a powerful arm into one of these veins, and used as a lever, the whole mass will split into two parts, from one end to the other, following the course of the vein; and with equal facility, by proceeding in the same manner, may new divisions of the glass be obtained in the other veins, till the whole piece is divided into a number of plates proportionate to the number
of

of veins: but if we attempt to divide them in any other part but the vein, they only break into small irregular fragments.

When we examine the face of one of the plates thus divided, we perceive that every vein consists of a thin leaf of earthy and scoriaceous particles, which prevents the vitreous strata from perfectly uniting. The direction of these veins, which intersect the glass transversely, is, generally, from above to below; and it appears evident to me, that the plates or sections of glass interposed between the veins have been produced by as many different flowings of the fluid matter. The formation of the earthy veins I conceive to have been as follows. The first stream, that is to say the lowest of all, containing lighter and less fusible particles than the remainder of the liquefied vitreous matter, these floated on the top; and the glassy current, cooling, produced, or rather left on the surface, a first pulverous coating, which prevented the perfect union of the second current that succeeded the first; and

and this second, containing similar subtle matters, prevented in like manner the full adhesion of the third; and so of the rest. Thus have successive flowings of the liquid matter produced the masses of glass we now see, exhibiting those apparent veins, in which they may be so easily split. But as we shall have occasion to speak of other glasses, in another place, we shall then have an opportunity to resume the subject of this peculiar texture.

Such were the observations I made on that rock, and some fragments which had fallen down from it on the shore; since, though it is composed of hard lava and glass, yet from the numerous fissures in it, caused by congelation, it has sustained many losses. In fact there is danger that it may become so entirely ruinous as to occasion its fall, together with that of the castle it supports.

I cannot dismiss this subject without mentioning certain circumstances which induce

duce me to believe that the inside of this rock is one prodigious mass of glass. The waves of the sea, by incessantly beating against it, have corroded it in several places, but especially towards the middle, where they have formed a spacious cavern ; which, as the lower part of it is covered with water, I entered in my boat, and found that the sides were real and solid glass.

In other places, against which the sea has dashed, and more or less broken the rock, the same vitreous substance is apparent. If we ascend from the shore to the castle, in more than one place near the road, which lies over lava, we find volcanic glass. In the small square, near the house of the commandant, we find it rising above the ground in large pieces resembling steps. Great masses of it likewise project from the ground within the city, in two places of which, having caused the earth to be dug into, I found the same glass.

All these facts and observations appear to

me

me sufficiently to support my opinion, which, as I have said, is, that the inside of this vast rock is entirely of glass. We perceive therefore that though, on making the circuit of the other parts of the island, we should not be able satisfactorily to ascertain its nature, these facts alone would be more than sufficient to prove it volcanic; and an intelligent though indolent traveller, who on arriving at Lipari should only take the trouble to go over the city, would perceive, in a few hours, what in many other countries, once subjected to the action of fire, he would not be able to discover in a much greater number of days.

But the indubitable testimonies of the ancient existence of fire in this place do not conclude here. The vitreous substances are frequently accompanied by pumices which are, in fact, only an imperfect glass. If we view the steep masses of glass and lava, which rise perpendicularly from the sea, like a wall; we perceive that they are interspersed with different strata of pumice,
from

from which, by the aid of a pole tipped with iron, small pieces may be broken off. On the shore, however, we do not find it in any great quantities.

This pumice is of two kinds, the one heavy and compact, the other light and porous, and both of a cinereous colour. The compactness of the former species, however, is not so great, but it may be broken into small pieces, and crumbled into powder between the fingers. It is dry and rough to the touch, is filamentous in many places, and crackles between the teeth; qualities appertaining to common pumices. Its structure is not every where filamentous, but in some places so fixed that its fibrous texture cannot be discerned. By the aid of the lens we perceive that it is of a vitreous nature, and discover an infinity of lucid points, which we might take for very minute felspars, did not a careful examination with a good magnifier shew them to be real particles of glass. It cannot be denied, that this pumice is of the same nature

with

with the lava of the rock, since we see, in many places, the lava gradually lose its solidity and fineness of grain, and assume the characters of this species of pumice.

The other kind is rather scaly than filamentous, and its scales have a degree more of vitrification than the other; the confluence, likewise, of some of these scales has produced, in several places, small lumps of a black glass. It is, however, extremely light in consequence of the pores and vacuities with which it abounds. This pumice is usually a continuation of the other, and, in my opinion, derives its origin from the greater degree of heat which it has sustained.

After having examined, and attentively considered on the spot, this mixture of lava, glass and pumice which forms the body of the rock, it appears evident to me that there have been several currents that have flowed down the sides, and, perhaps, from the summit, of the contiguous mountain della Guardia,

Guardia, into the sea, since the direction of their descent is found on that side, and even the filaments of the pumices point towards that mountain.

If we except those minute globules, which appear to me to be portions of lava, this lava, glass and pumice, exhibit neither felspar, shoerls, nor any other extraneous body ; either because these have been melted by the fire, or, perhaps, because they never existed in them. But in what manner this fire must have acted in fusing those masses of felspar of which the rock that supports the castle of Lipari is formed, so that this stone should now have remained a simple lava, and now have passed into the state of glass or pumice, shall be considered in another place ; at present I shall proceed to state other facts analogous to the same subject.

The lava and glass of the rock, when exposed to the furnace in separate crucibles, fused into a light-grey glass, the globules which before appeared in them melting at

the same time. This glass is incredibly porous. Though the crucible in which these substances were fused was only filled to one quarter part of its contents, they swelled so much when in a state of liquefaction, that they rose several lines above the edges of the crucible, and flowed over, down its side.

The two kinds of pumice, though both derive their origin from the same felspar, which is the base both of the lava and the glass, afford different results in the same fire; since their volume, instead of augmenting, is diminished; only retaining its former colour.

The tumefaction or inflation of this glass may, perhaps, excite some surprise; since it implies a prodigious quantity of gaseous bubbles contained within it; whereas nothing of the kind is observable in it, when it is acted on by the fire. But we shall see hereafter that this is an appearance common to almost all glasses and compact volcanic

canic enamels, and which I shall consider when I come to speak of the nature of the gaseous substances that frequently tumefy more or less different volcanic products : at present my object is only to state and compare facts. I shall only say that I have never met with any thing similar in the refusion, not only of common factitious glass, but even of that which is sometimes produced in the furnaces for baking bricks and tiles. A few years ago a large piece of glass was put into my hands which was said to be volcanic, but of which I entertained doubts, since, though in its great weight and hardness it resembled the volcanic glasses, it differed from them in certain spots and blueish streaks, and in a kind of little stars, which seemed to indicate a principle of crystallization in this glass ; neither of which appearances I ever observed in the glasses of volcanos ; and on a careful examination, to discover with certainty its origin, I found that this glass had been brought from a tile-kiln. When re-melted in a glass furnace it retained its former solidity

and compactness, without exhibiting the smallest pore or bubble; and instead of swelling in the crucible, and assuming a convex superficies, it sunk, and acquired a concave one. I have observed the same in two other similar glasses.

The haven of Lipari forms a curve in the shore which to the south begins at the foot of the Monte Capiscello, and ends to the north-east at the bottom of the Monte della Rosa*. After having therefore examined that part of the shore which is contiguous to the harbour, lying under the castle, and on the right side of Monte Capiscello, I made the circuit of the remainder of that curve to the base of Monte della Rosa. The objects which here attracted my notice were first a tufa above a lava, which the industry of the inhabitants had converted into a soil suitable to small vineyards; and next a mass of crags and precipices, partly fallen into the sea, and partly threatening to fall,

* See Plate VI.

among

among which, besides scoriz of an iron colour, we meet with beautiful volcanic breccias of a lava of a petrosiliceous base, and containing small particles of glass and pumice.

I cannot think of this place without shuddering at the dreadful danger to which I should have been exposed had I visited it two days later. I was there on the 21st of September, and examined the breccias which had fallen down on the shore, and those, much more numerous, and more deserving attention, which remained still attached to the rugged declivity that descends into the sea. On the 23d, in the afternoon, almost the whole of this declivity fell down with a dreadful crash. I was at that time taking my afternoon's nap in the house which had been politely appointed for my reception by the Consul of Lipari, and is situated on the shore of the harbour. The noise immediately waked me, and at first I could not tell whether it was a violent clap of thunder, an earthquake, or the roaring of the waves in a tempest. I ran to the window,

and perceived that it came from the declivity I have described, but could discern nothing but an immense cloud of dust by which it was covered. The noise lasted, perhaps, five minutes; and when the cloud of dust had somewhat dispersed, I perceived it was occasioned by a prodigious quantity of stones that had fallen down into the sea, and that a great number continued still falling.

Two sensations, on this occasion, most powerfully affected my mind; the one of shuddering and horror on reflecting that my destruction must have been inevitable had I postponed my visit to this place two days and a half, and the other of satisfaction and joy at my fortunate escape.

The fall of so great a quantity of stones, produced a large longitudinal furrow in the declivity, and a small indentation in the sea. The next day I procured several of these stones, and found that they were pieces of lava, partly of the horn-stone base, and partly

partly of that of felspar. The latter had a fine grain, and some transparency when in thin pieces; the former were of a coarser grain, and opaque. When I went in the boat to examine the part of the mountain where these stones had fallen, I perceived that it was formed of loose volcanic stones, which were very liable to fall from the steepness of the declivity, and I judged them to be fragments of lava, detached, by length of time, from a more elevated rock, and afterwards accumulated below, at a little distance from the sea.

Having arrived at the foot of the Monte della Rofa, where, as I have said, the harbour of Lipari ends, I perceived on the shore a stone, which, from its singularity, drew my attention. It forms a rock that in part rises above the sea, and in part is concealed by the water. There are also several detached pieces of it which have been made round by the action of the waves. I, at first, took it for a jasper. Its ground was of a blood-red colour; it gave sparks strong-

ly with steel, was of a rather fine grain, and had almost the hardness of quartz. When I first saw it, it reminded me of the jasper I had observed and collected at Schemnitz in Lower Hungary, under the hill Calvario, and of which some specimens are preserved in the Imperial Museum, it appearing to me that these two stones were extremely similar; but on a more attentive examination, I perceived that this stone was not simple like the jasper, but of a compound formation, containing in it reddish scales of felspar, and shoerls, which gave it the character of that kind of porphyry which has for its base a hard horn-stone. But is this porphyry in a natural state, or in that of lava? Lavas of a red, and a bright red, colour, I confess, I had never before seen, nor do I know that they have been observed by any other naturalist; and I therefore doubt whether the detached red porphyry I found at Stromboli had ever suffered the action of the fire. It is true that many lavas near the stoves of Lipari and elsewhere have this colour, as we shall see in the following chapter;

ter; but this arises from the decomposition they have suffered by the force of sulphureous acids, and the action of iron: and I shall there shew that the red colour (and the same may be said of the white, green, and other colours) has only penetrated as far as the action of these acids, and, consequently, the decomposition, has extended; but where the lava remains untouched by them, it still retains its natural colour, that is, either a grey, or the colour of lead or iron, but without any mixture of red. We do not, however, discover any traces of decomposition in the production of which I now speak. After the most careful examination, I cannot exclude it from the number of true and real lavas; though, on the other hand, I am unable to affirm that its redness is an effect of calcination, as is the case in other lavas, since of this it does not exhibit the slightest indication. We must here, therefore, have recourse to one of those limitations which experience has obliged us to admit in many other rules of philosophy, which were at first thought to

be absolutely general, but afterwards found to be subject to more than one exception. The reasons of fact on which I found my assertion, that this porphyritic rock has passed into the state of lava, are two: the great number of minute cells it contains in many parts of it, and the direction of those cells. Where local circumstances are insufficient to determine, the compact lavas rarely leave the enquirer in doubt whether they derive their origin from fire, as the fire has not so changed them as to destroy the characters of the stone from which they were produced. But it is not the same with the cellular, since it is known that their configuration can only be the effect of aëriform fluids, put in motion by the action of the fire. This cellular conformation is found in the present stone. The cells in many large pieces are so numerous, as to occupy nearly one half of the volume of the stone. The largest are about five lines, and the smallest a quarter of a line; but between these two extremes there are an infinity of intermediary sizes. It is worthy of remark, that these

these cells are not only superficial, but extend into the internal part of the mass, as is seen in fractures two or three feet in depth, which may serve to obviate the objection that even stones not of volcanic origin, are sometimes cellular, since it is known that their cells or minute cavities are merely superficial, and originate from the corrosion of some of their external parts, by the filtration of the rain water. This proof is supported by another still stronger, taken from the direction of the cells, which is the same in all, as well in the pieces detached from the rock, and deprived of their sharp edges by the waves, as in the rock itself. This direction is every where found to be from the Monte della Rosa to the sea, as they form ellipses more or less acute, the greater diameters of which are invariably in that position, and this greater diameter is frequently twice or three times the length of the less. This stone, therefore, is not only a true porphyritic lava, but it is evident that it once flowed from the mountain above mentioned to the sea, and in its motion

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the naturally circular figure of its pores or cells was changed into an oval. I have almost always observed the same appearance, on a smaller scale, in re-melted lavas, and glasses. As long as the matter in fusion remains within the crucible, the bubbles are orbicular, but become elliptical in that part of it which overflowing the edges runs down the side of the crucible; and the greater diameter of these ellipses is generally in the direction of that side.

All the pieces of this kind of lava are not, however, of a blood-red colour; some of them are of a duller red, though the component principles of both are essentially the same.

This lava, when fused in the furnace, doubled its volume, and its upper part assumed a vitreous convexity, which was smooth, shining, semi-transparent, and of a greenish tincture; but internally it was a very black vitreous scoria, extremely porous, and sufficiently hard to give sparks with steel.

With

With these observations on this uncommon species of lava, I shall conclude the account of my tour round the harbour of Lipari, which may extend about two miles. According to my proposed plan, I was now to proceed to make the circuit of the island, which I did, taking my departure immediately from the foot of Monte della Rosa, and proceeding towards the north.

At the distance of somewhat more than three hundred feet a lofty rock rises from the sea, of a horrid and dreadful aspect, formed of large plates of stone, feebly supported by projecting points, and appearing to hang in the air, and threatening to fall, as many have already, the fragments of which are seen on the shore. I must candidly confess, that, after the fall of the rock I have already mentioned, I approached this with no small dread. My ardour to make some new discoveries, however, triumphed; and, as I was afterwards frequently obliged to risk myself in similar situations, in order to examine accurately
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the shores of the island, I gradually acquired an habitual courage, and became almost incapable of any idea of danger. I hope I may be pardoned this little digression.

The Eolian isles, especially Lipari, Felicuda, and Alicuda, are, at their bases, more or less corroded by the sea, which, there, is so frequently in a state of violent agitation. The lower excavations cause the parts above them to give way, and, in a series of years, great masses fall into the sea. To this the nature of the lava, which is full of cracks and fissures, considerably contributes; not to mention the influence of the humidity of the atmosphere, and other destructive elements. Large heaps of these fragments, in consequence, accumulate on the shore, where they are dispersed by the waves, and make room for others, and thus a gradual diminution of the island takes place.

These corrosions of the water, these fissures,

fures, and fragments of the stones and rocks are, however, peculiarly interesting to the enquiring naturalist, who, though he may make important discoveries while traversing the summits and sides of volcanic regions, can never penetrate beyond the surface. The internal effects of the fire, the substances more or less modified by it, and sometimes prodigiously changed, even to the entire annihilation of the character of the original stone, and many other combinations produced in the subterranean recesses, by this ever active element, can only be known by incavations and fractures which exceed the strength of man to effect, but which, to a certain degree at least, are in many places produced by the sea. Of this we have already mentioned some instances, observed in making the circuit of the shores of the other islands, and shall adduce others in those which yet remain to be described; we have also a very remarkable example before us, in the half-destroyed rock of which we are now speaking.

Above,

Above, it is covered with a thick coating of earth, which prevents its true character from being visible; but on the shore it may be very distinctly seen, and appears to be formed of a lava, in thick strata, taking an oblique direction to the sea. This lava is likewise porphyritic, of a petrosiliceous base, containing crystallized felspars, and, like the other rock I have before mentioned, of a red, but rather a dull red colour. It is not in the least porous, but extremely compact and solid, and is consequently extremely heavy, and rather of a siliceous than earthy grain. It lies on the shore, in large pieces; the solidity and beauty of which, when well polished, would render it a no less splendid ornament in buildings than the porphyries which are not volcanic.

The degree of heat which fuses the other porphyritic lava is only sufficient to soften the present, and make it take the shape of the inside of the crucible and adhere strongly to its sides. It then assumes a black colour, and loses its compactness, becomes
filled

filled with small round bubbles. In a more intense heat, it melts into an enamel, in like manner black and filled with bubbles: the felspars, however, remain untouched, as in the enamel produced from the other porphyritic lava.

Continuing my tour beyond the harbour and the porphyritic rock, I found the sea form a kind of bay within the land, round which a few cottages are built, affording shelter to a small number of inhabitants who live by the profits of a vineyard that but ill repays their labour. The name of this place is Canneto; and above it is a current of lava, of an argillaceous base, similar to that of the Arso in Ischia*. This lava is not continued without interruption; but, like that of Ischia, broken, unequal, and here and there raised into a kind of little hills. Its external appearance is, on a larger scale, that of a field ploughed, with several furrows in an irregular direction, having great hillocks and

* See Chap. V.

deep intervals between them. I have observed this appearance in several other lavas, beside the present, and that of the Arfo; and the cause of such a conformation may, it appears to me, be the following. It frequently happens that the lavas, when they flow, meet with impediments in their way which obstruct their course. When, therefore, such an obstacle occurs, the stream must stop, or its motion become slower; but this not taking place in the parts behind, they continue to flow, and increase the quantity of the lava, which swells in that place, and, in consequence of its contact with the cold air, soon loses its fluidity, and is congealed into stone. The liquid lava, in the mean time, takes its course another way, if the obstacle is insurmountable; and if it meets with others, new stoppages or retardations are the consequence, producing other tumors; and thus the lava, in many places, becomes full of hillocks. It may likewise be, that the lavas, flowing over places abounding with cavities, of which there are many in volcanic mountains, may partly sink into them,

them, and, thence, afterwards rise somewhat above the former level; and thus produce the small elevations which are here observable.

I had now continued my tour, in the boat, till I approached Campo Bianco (the White Field), distant three miles from the haven of Lipari, and so called because it is a lofty and extensive mountain composed entirely of white pumices. When seen at a distance, it excites the idea that it is covered with snow from the summit to the foot. Almost all the pumices that are employed for various purposes in Europe, are brought from this immense mine; and Italian, French, and other vessels continually repair hither to take in cargoes of this commodity: the captain of the ship which had brought me to Lipari, had sailed from Marseilles to carry back a freight of this merchandize. I was not, however, actuated merely by those motives of curiosity that might induce any traveller to visit this remarkable mountain; I proposed to examine it with the eye of a philosopher and a naturalist.

The pumice-stone, with respect to its origin, though universally admitted to be the product of fire, is one of those bodies which have divided the opinions of chemists and naturalists both ancient and modern. It may, in fact, be affirmed that it has given rise to as many hypotheses, and extravagant suppositions, as the question, formerly so much agitated, relative to the nature of the yellow and grey amber. Without noticing the more absurd of these, I shall only mention that Pott, Bergman, and Demeste imagined that pumices were amianthuses decomposed by the fire; Wallerius, that they were coal or schistus calcined; Sage, that they were scorified marles; and, lastly, the Commendator Dolomieu, that they were granites rendered tumefied and fibrous, by the action of the fire and aëriform substances.

The most effectual method to investigate the truth in so obscure a question, appeared to me, to make the most accurate and minute observations on the spot; to collect and attentively

attentively examine the pumices most suitable to this purpose; and to make further experiments on them after my return to Pavia; which practice I likewise observed with respect to the other volcanic products.

Campo Bianco is a mountain that rises almost perpendicularly from the sea, and which, seen at a distance, appears to be about a quarter of a mile in height, and above half a mile in breadth. No plants grow on it, except a few which bear no fruit, and likewise grow on the tops of the Alps. Its sides are streaked with a great number of furrows, that grow deeper and wider as they approach the bottom, and have been formed by the rains, which easily corrode and excavate a substance so soft and yielding as punice *. The sea at the foot of it has likewise occasioned great devastations, by means of which we discovered a large vein of horizontal lava on which the last waves die away when the sea becomes

* See Plate VIII.

calm. The formation of this lava was, therefore, prior to the vast accumulation of pumices which rest upon it.

On attentively viewing this prodigious mass of pumice, we soon perceive that it is not one solid whole, and forming only one single piece; but that it is an aggregation of numerous beds, or strata, of pumices, successively placed on each other; which beds are distinguishable by their colour, and in many places project from the mountain. They are almost all disposed horizontally, and their position is not dissimilar to the stratifications so frequently met with in calcareous mountains. Each bed of pumices does not form a distinct whole, which might lead us to suppose that they had flowed at different intervals, and every current produced a bed or stratum; but it consists of an aggregate of balls of pumice united together, but without adhesion. It is hence evident that the pumices were thrown out by the volcano in a state of fusion, and took a globose form in the air, which

which they preserved at the time of their sudden congelation. We find many such eruptions of pumices in the Phlegrean Fields; as, for example, that which overwhelmed and buried the unfortunate town of Pompeii. The excavations which have been made, to exhibit to view some parts of that city, manifestly shew, that repeated ejections of small pumices in immense quantities from Vesuvius, have covered it with vast accumulations of that substance, disposed in different beds or strata.

A great quantity of these Liparese pumices, of a globular form, are first met with on the shore near Campo Bianco; but as I doubted whether the action of the waves might not concur to produce the roundness of their figure, I rather chose to make my observations on those that actually formed the beds, which I did, by climbing up one of the sides where the ascent, though difficult, was not impracticable. Here I found pumices approaching some more, some less, to the globular form, and

of different sizes, some not being larger than nuts, and others a foot or more in diameter, with innumerable sizes between these extremes. Though the ground-colour of them all is white, in some it inclines to yellow, and in others to grey. They swim in water, do not give sparks with steel, nor cause the least motion in the magnetic needle. Their fracture is dry and rough to the touch, their angles and thinner parts are slightly transparent; and their texture, in all of them when viewed through the lens, appears vitreous; but this texture has diversities which it will be proper to specify.

Some of these pumices are so compact that the smallest pore is not visible to the eye, nor do they exhibit the least trace of a filamentous nature. When viewed through a lens, with a strong light, they appear an irregular accumulation of small flakes of ice; their compactness, however, does not prevent their swimming on the water.

Others are full of pores, and vacuities of a larger

a larger size, usually of a round figure; and their texture is formed by filaments, and streaks, in general parallel to each other, of a shining silver whiteness; and which, at first view, might seem to be filken, did they not present to the touch the usual roughness of the pumice.

These varieties are not only observable in different globes of pumice, but frequently in the same: it is therefore indubitable that these differences are not intrinsic and essential to the nature of pumices, but accidental, and arising from the action of aëri-form fluids, which, dilating them in many places, when they were in a state of fusion, have produced that multitude of pores, and those filaments and subtile streaks, that denote a separation of the parts; whereas the other pumices, which have not been acted on by these gases, have preserved that compactness which results from the force of aggregation.

The fractures of the compact pumices
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are, in some places, shaded with a blackish, but at the same time shining, tinge; which, when carefully examined, is found to be caused by a greater, though still a very slight, degree of vitrification of the pumice itself; either because the fire has there acted with somewhat more force, or because the parts were, there, more easily vitrifiable.

The pumices hitherto described, form one of the species which the Liparese sell to foreign traders.

None of these, so far as can be discerned by the eye, or even with the assistance of the lens, contain any extraneous bodies; but were we too hastily to conclude that they really do not, we should commit an error, as their vitrification by artificial means will prove. When kept in the furnace during an hour, they become only more friable and of a reddish yellow colour; but when continued in the same heat for a longer time, they condense into a vitreous and semi-transparent mass, within which appear a number
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of small white felspar crystals that were not visible in the pumice, because they were of the same colour. These stones, however, are not seen in every pumice thus fused; either because it did not contain them, or because they have melted into one homogeneous mass with the pumice. This is one of the many important cases in which we are able, by the means of common fire, to discover the composition of volcanic products which had at first been supposed to be simple.

But to render complete my enquiries relative to the pumices of Campo Bianco, it was necessary that I should not confine my researches merely to the part of the mountain I have mentioned, but extend them to all the principal places where they might be found. This I did, accompanied by two natives of Lipari, whose assistance was particularly useful to me, as they lived by digging pumice, and were well acquainted with every part of the mountain, and the different kinds of pumices it contained. It

is impossible to describe the difficulties I met with in these excursions. We frequently passed along the edges of the deep ditches made by the rain-water, at the hazard, in case of a false step, of falling into them, and not easily getting out again; or the still greater danger of precipitating into the sea. The dazzling whiteness of the pumice, equal to that of snow, increased my fears; for I made my excursions in the day-time, when the sun shone, and was strongly reflected by these stones. Every one knows that snow, besides dazzling the sight, is accompanied with the inconvenience, when it is deep and has lately fallen, that the person who walks on it sinks into it to a greater or less depth; and the same inconvenience is experienced from the pumice, which in many parts of Campo Bianco is reduced to a powder several feet deep, and, when the wind blows on it, sinks in on one side, and is heaped up on the other. All these difficulties and obstacles I, however, surmounted, animated by that ardour which inspires the philosophical traveller, and enables him
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to brave the greatest dangers, and such as can only be known and appreciated by those who have engaged in similar undertakings. I can affirm, therefore, with great satisfaction, that with the assistance and guidance of the two Liparese, there was no corner of the mountain that I did not visit; and when I reached the summit, and saw that it joined another mountain, the foot of which was in the sea, and which was, in like manner, composed of pumice, I extended my researches to that likewise, and examined the different species of pumice it afforded, or rather which compose a very considerable part of it. I shall proceed to describe them severally, with as much brevity as possible.

I shall first mention those which constitute a branch of commerce at Lipari, and are applied to various purposes. One of these has already been sufficiently described: I shall only add, that it is found in considerable quantities in Campo Bianco, but solely in detached pieces, and not forming currents

or

or veins ; whence it is evident that it has been ejected from the volcano, and has not flowed in the manner of lava.

The second species is cut by the labourers in parallelopipeds, about twenty-two inches long, and eight broad. This pumice is of a dark dirty colour, contains no extraneous bodies, gives a few sparks with steel, and is so light that some pieces of it will float on the water. It is formed by an agglomeration of pumiceous bubbles, which are, as it were, conglutinated together, and incline more or less to an oblong figure. To detail their various sizes, would be useless prolixity. I shall only say, that from the very minute, and, if I may so term them, infinitesimal, they increase in size till some of them exceed an inch in diameter, though the latter are less numerous than the former. They are all extremely friable, as their sides are very thin, and always semi-vitreous. The glass of many of them is white, and has some transparency ; but in others is dull, and almost entirely opaque.

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As I do not know that this species of pumice has ever been described before, though it certainly well deserves attention, I would wish my description to be as clear and explicit as possible. It has been already said, that many lavas, and other volcanic productions, on re-fusion, become cellular. To apply this to the pumice in question would be an error. A lava, which has undergone this change by the action of elastic gases, continues to form one whole, though interrupted by these multiplied pores. The pumice, of which I now speak, is principally formed by an accumulation of small vitreous vesicles, which attached themselves to each other while they were yet soft from the action of the fire; and which, from their globose figure, not adhering except in a few points, have left many vacuities very visible on the fracture of the pieces. The labourers who dig these pumices, after they have shaped them into parallelpipeds, take them on their backs and carry them down to the shore, where they pile them up in large heaps, to be ready

ready for sale when opportunity shall offer. We are not to imagine, however, that this species of pumice is to be found in every part of the mountain: the workmen, to find what they call the vein of it, are obliged to make great excavations, and frequently without success, which, as they told me, in this case, as in fishing for coral, often depends on chance. When they have found the vein, they dig it, following its direction; in which laborious employment a number of men are occupied for whole weeks, the vein being sometimes a hundred and fifty, two hundred, or even three hundred feet long, and large in proportion. These veins are called *Faraglioni*. I have examined them, and satisfied myself, that the accounts I received were true. Pumice-dust, and large heaps of the first species of pumice, with some scattered vitrifications, usually cover these veins, which, when viewed with the attentive eye of the naturalist, give reason to believe that they are long tracts of pumice, which once flowed in a liquid state. Their bubbles frequently lengthened in

in the direction of the vein, seem, likewise, to prove the same.

M. Dolomieu, who first suggested that many pumices have flowed in currents like lavas, observed that, at Campo Bianco, the lighter pumices lie above the heavier; in the same manner as in the common currents of lava the porous lavas occupy the highest place. I have certainly observed this disposition; but sometimes it proves fallacious: for, if the excavation be continued below the vein which forms the second species of pumice, we frequently again find masses of extremely light and pulverulent pumice.

The first action of the fire of the furnace thickens the sides of the vitreous vesicles, of the second species, and diminishes the internal pores. A longer continued heat entirely annihilates the pores, and changes the pumice into a fixed, obscure, homogeneous, and hard glass, which gives sparks plentifully with steel.

The third species is likewise an object of traffic with the natives of the island, who dig it in the same places where they find the second ; and, in like manner, shape it into parallelopipedons. This is likewise an aggregate of bubbles, but differing from those of the former in several respects. Those, as we have seen, are conglutinated together in some points, while they are separate in others, so that we can frequently detach them without breaking ; while these, on the contrary, are so incorporated by different solid points, that, if we attempt the separation of one, we break the others that are contiguous. Here the elastic gases, investing the pumiceous substance in several points, have expanded it in every part into tumors and cavities, nearly as we see in raised and baked paste. It is worthy remark, that, frequently, when we break one vesicle, we meet with another within it, and concentrical. There is likewise another difference between these two pumices. The vesicles of the second species are all more or less vitrified ; but many of the third shew

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no signs of vitrification, are extremely friable, and of a pale red colour.

This pumice, though destitute of any fibrous texture, is specifically lighter than water. To obtain it, large pieces of white pumice, of the first species, in which it is enveloped, must be removed; and it commonly lies in long tracts, in the direction of which its vesicles are sometimes lengthened, which may induce us to suspect that this likewise, when it was liquid, formed small currents. It contains no extraneous bodies.

In the furnace it condenses into an obscure mass of glass, almost opaque, but little porous, and sufficiently hard to give sparks with steel.

These are the three kinds of pumice which the people of Lipari dig for sale. The first is employed in polishing different substances, and the other two are used in the construction of arched vaults, and the

corners of buildings. There are, however, other species which deserve the attention of the naturalist, and which I shall here proceed to describe.

On Campo Bianco, and in its environs, we find a fourth species of pumice, of a filamentous and extremely black texture. It is rough to the touch, scarcely at all porous, so heavy as to sink in water, and gives sparks moderately with steel. This pumice likewise contains no extraneous substances. Though when viewed in the mass it appears entirely opaque; its filaments when detached, and examined by a strong light, appear to be transparent, and only dark from their black colour. The second and third species are vesicular; but in this there are not any vesicles. The threads or filaments of which this fourth species is composed, have all one direction, which is that of the current. It is here necessary to observe, that though this black pumice is found scattered on the sides of Campo Bianco; in a rock which descends almost perpendicularly
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into the sea, it forms an entire vein almost horizontal, which enlarges from the breadth of seven feet to twelve, and is above sixty feet in length. If we here examine the structure of this pumice, we shall find that, besides being filamentous, as we have before described it, its filaments preserve a parallelism among themselves, and the direction of them all is from the mountain to the sea; there can therefore be no doubt but this vein may be considered as a true current of pumice.

I was at first inclined to believe that the black colour of this pumice proceeded from iron, but afterwards suspected that it was rather the effect of a bituminous substance, from the strong scent of bitumen which it emitted on rubbing two pieces of it together; and my suspicion was afterwards confirmed by its losing its black, and acquiring a white colour, by remaining a short time in the furnace: on a longer continuance it became a vitreous paste.

But among the different productions of this nature, there is none which more merits attention than that of which I now proceed to speak, and from which originate no small part of the pumices of Campo Bianco. This is a lava, with a felspar base, which is found over the whole mountain and its environs, rising in rocks and crags of an enormous size. It is of a grey colour, of an appearance between siliceous and vitreous, with a consistence or grain less fine than that of quartz, having a small degree of transparency in the angles, and sufficient hardness to give sparks with steel. On attentively examining this lava, we may distinctly perceive in it the gradual transition of the lava into pumice. In many pieces of it we find the external appearances above described. In others the lava begins to soften, and become friable and rough to the touch, but without losing its siliceous-vitreous appearance. In many others we discover the commencement of the pumiceous character. Some small cavities in this lava exhibit minute groups of fibres, of a silvery whiteness,

whiteness, light, extremely friable, but only discernible by the lens. These crackle between the teeth, and rub to powder under the finger; but, at the same time, shew they have a rough grain, and, in a word, prove, by the most indubitable marks, that they are real pumice. On breaking other pieces, the groups or clusters of fibres are found more fixed and large, so as to occupy a great part of the lava, which becomes lighter even where there are none of these clusters, since its texture becomes thinner, though not at all porous; and here the nail only is sufficient to scratch and break them, and the eye accustomed to pumices recognizes the characteristic marks of that substance, though they are not so apparent as in the filamentous aggregates. Lastly, it is not uncommon to find masses of lava, which on one side retain the characters of felspar, and on the other are changed into the first species of pumice, entirely resembling it in colour, lightness, structure, and its other exterior characters. In this pumice we likewise perceive many crystallized felspars,

such as we find them in the generative lava, and seemingly not at all injured by the fire.

We thus clearly discover the origin of the first described species of pumice. I must here remark, likewise, that these masses of lava, even where they do not appear pumiceous, if they are trituated and pulverized, produce a powder resembling in every respect, the whiteness of its colour not excepted, that which, in immense quantities, covers, and lies deep in the mountain, and which is produced from the pumices of the first species. The furnace reduces this pumice to a kind of glass, resembling that obtained from the first species.

All these circumstances concur to prove the identity of this pumice derived from the felspar, with that first described. I shall only observe, that if the greater part of this kind of pumice has not formed currents, but been thrown out, at different times, in detached pieces from the volcanic furnace,

as has been before remarked, another portion has actually flowed; that, for instance, which in many parts of Campo Bianco is united to the felspathose lava.

This lava, however, merits to be considered in another point of view. Hitherto we have only noticed it as the original base of pumice, but we shall likewise find it productive of glass. To be convinced of this, we have only to examine some other pieces from the same mountain; some of which, without losing the appearance of the felspar, begin to assume the veins of glass, and are at the same time filled with innumerable small bubbles, that are likewise vitreous. But this glass differs from that of the pumices by being more perfect, and more transparent. In other pieces the bubbles are larger, and the small vitreous veins more numerous. On breaking a large mass, or following the large veins, we find in some parts groups of felspathose lava, in others pieces of vesicular glass, and in others solid glass.

But

But whence has it happened that the same rock in some places has been changed into pumice, and in others has become glass? since, though the greater part of pumices are vitreous, their glass is far from being so perfect as that in question; which likewise differs from the pumices in this, that though it forms vesicular masses, these masses have a hardness that can never be compared with the usual friability of pumices.

The origin of this difference, it appears to me, may be explained as follows: A certain degree of heat has produced a semi-vitrification in the felspar, which has changed it into pumice. Such a degree of heat therefore was only sufficient for the production of this stone; but a stronger, or, perhaps, a longer continued heat, has produced a complete fusion, that is, a perfect glass, sometimes abounding in bubbles, from the abundance of the gaseous substances with which it is penetrated.

Seven varieties of these cellular glasses,
 4 which

which are all of a cinereous colour, having been exposed for several hours to the furnace, on their re-fusion, were reduced in volume, and the new glass was consequently deprived of that multitude of pores it before contained.

But to return to the pumices: we have now ascertained that there are four species, of which Campo Bianco and its environs are principally composed.

It may, perhaps, be objected, that the second and third species which I have described, do not properly belong to the class of pumices, as they are both vesicular; whereas, one of the characters of the pumice is the filamentous texture.

I admit without hesitation, that many pumices used by artists to polish different substances have this character; but others employed for the same purposes, and, perhaps, in equal quantities, and which no person has ever doubted to be pumices,
have

have no sensible trace of filaments. Of this every one may convince himself by an inspection of the pumices usually sold. Besides, even those that are filamentous do not constantly retain that character; of which the first species furnishes numerous examples. Of this, large masses are found on the shore, cut by the natives into pieces for sale; among which I have observed, that, though many pieces have the filamentous texture, there are many others which have it not, either externally or internally. The same I observed in many of the scattered pieces with which the mountain abounds. If, therefore, the filamentous texture be not a character essential to the pumice, I do not see why the stones of the second and third species should not be considered as true pumices, since they bear all the other marks by which the pumice is characterized. It may be added, that at Lipari, and in commerce, they are denominated pumices, and names adopted by the arts ought not to be changed without absolute necessity.

From

From these observations, made at Campo Bianco, we begin to obtain some light relative to the origin of pumices, since we have seen that those of the first and fifth species have the felspar for their base. The same has likewise been shewn of the others contained in the rock on which the Castle of Lipari is built. We still, however, remain in uncertainty with respect to the second, third, and fourth species, from their being always found in the state of complete pumice, and never met with in those strata or masses of lava, which, by shewing the first principles of these pumices, might enable us to discover the stone from which they have originated. To attain this discovery, it was, therefore, necessary to analyze these three species by the humid method; and though the base of the first and fifth species, as also of that from the rock of the Castle of Lipari, was sufficiently evident; I yet, for the greater certainty, resolved to subject these likewise to the same analysis; and, while employed on this operation, determined at the same time to make similar experiments

periments on some pumices of other countries; that, for instance, which is found in small quantities in the Arso in the island of Ischia, and two other kinds from the island of Santorine in the Archipelago, a country certainly volcanic. Both the latter species are white, and float in water; but the texture of the one is compact and equable, and that of the other full of pores, and extremely filamentous.

The following are the results I obtained.

First Species of Campo Bianco.

Silex	-	-	60.3
Alumine	-	-	23
Magnesia	-	-	6
Lime	-	-	6
Iron	-	-	3

Second Species.

Silex	-	-	80
Alumine	-	-	6
Magnesia	-	-	3
Lime	-	-	4.7
Iron	-	-	4.8

Third

Third Species.

Silex	-	-	-	86
Alumine	-	-	-	4
Magnesia	-	-	-	2
Lime	-	-	-	4
Iron	-	-	-	5.3

Fourth Species.

Silex	-	-	-	84.5
Alumine	-	-	-	4
Magnesia	-	-	-	3
Lime	-	-	-	2.1
Iron	-	-	-	4.2

As this fourth species emitted a bituminous odour ; before I analyzed it, I subjected it to distillation, in a sand heat ; from which I obtained a few drops of petroleum that swam on the water which had collected during the operation in the recipient of the retort containing the pulverized pumice.

Fifth Species.

Silex	-	-	-	61
Alumine	-	-	-	22.7
Magnesia				

Magnesia	-	-	6
Lime	-	-	5.8
Iron	-	-	3

Pumice of the Rock of the Castle of Lipari.

Silex	-	-	63
Alumine	-	-	24
Magnesia	-	-	5.6
Lime	-	-	3
Iron	-	-	2

Pumice of the Arso in Ischia.

Silex	-	-	54
Alumine	-	-	26
Lime	-	-	3
Magnesia	-	-	8.2
Iron	-	-	7

First Pumice of Santorine.

Silex	-	-	66.8
Alumine	-	-	4.2
Magnesia	-	-	14.7
Lime	-	-	11
Iron	-	-	3

Second

Second Pumice of Santorine.

Silex	-	-	69
Alumine	-	-	3
Magnesia	-	-	19
Lime	-	-	6
Iron	-	-	2

From these results it appears that the component principles of the first and fifth species of pumices of Campo Bianco, as also that of the rock of the Castle of Lipari, perfectly resemble those obtained by the analysis of various felspars made by different chemists ; among others, by Mayer, Fabroni, Heyer, Westrumb, and Morell.

The same agreement would be found in the second, third, and fourth species, were it not that they contain a greater quantity of silex, and less of alumine ; which, however, does not appear to me a sufficient reason for excluding the felspar from these three pumices ; both because I know no other stone hitherto discovered, and chemically analyzed, to which these component

principles can be more properly referred than to the felspar ; and because, the species of that stone being extremely numerous, it cannot excite surprise if some should differ a little from others, in the quantities of their constituent parts, which is the case in every kind of stone.

With respect to the pumice of the Arso in Ischia, it appears evident from its component principles, that its base is a hornstone, from which the current of lava, likewise, derives its origin.

Lastly, with regard to the two species of pumices from the volcanic Isle of Santorine, it appears, from the analyses adduced, that their base has been an asbestus, or, at least, some stone analogous to the asbestus : of this we shall be convinced, if we compare these two analyses with those made by Bergman of different kinds of the asbestus *.

* Opusc. Phys. Chem. Tom. IV.

If we now proceed to consider the various opinions relative to the origin of pumices, and examine them by the facts now stated, we shall certainly find that the hypothesis of the Swedish chemist, as also of Pott and Demeste, that pumices originate from the asbestos, is not without foundation; it is only erroneous in supposing that they are produced from that exclusively; since it has been shewn, that the base of the pumices of Campo Bianco, and the Rock of the Castle of Lipari is a felspar, and that of the pumices of the Arso a hornstone.

I foresee, that some will with difficulty be persuaded, that the pumices of any volcanoes have for their base either the asbestos or the amianthus, since these two magnesian stones are rare, and only found in small quantities. But this is a mistake; for we know, from the information of naturalists and travellers, that they are both found in many countries; as in the islands of the Archipelago, in Asia, in Persia, and Tartary, not to

mention Savoy, Switzerland, and Italy. It is likewise certain that the asbestus is found in some countries in such abundance that whole rocks are entirely composed of it, as in Siberia. I have some large pieces of asbestus, with parallel fibres, of a greenish grey, and difficult to separate, which were brought me, a few years ago, by one of my pupils, from Chiavenna, in the country of the Grisons, and taken, by himself, from Mount Ufchione, near his native place, which is full of this species of stone.

When we speak of pumices with an asbestine or amianthine base, it is always to be understood, that the volcanic fire which has produced them has been excessively powerful; since we know, from the experiments of D'Arcet, Saussure, and Ehrmann, how obstinately these stones resist the fire of the furnace when raised to an excessive degree of heat. The asbestus of Chiavenna, the Genoese territory, Savoy, Corsica, and other countries of Europe, after I had kept them a long time in a glass furnace, still
con-

continued refractory, having only lost their yielding consistence, and their flexibility.

From the great affinity between some serpentines and the asbestus, I cannot hesitate to believe, that should the furnace of a volcano be situated among the former, they would likewise be converted into pumice.

I cannot, however, by any means, subscribe to the opinion of Wallerius, that pumices are coal or schistus calcined; nor to that of M. Sage, that they are margaceous scoriæ; for, with respect to the former, we have seen that pumices are not in a state of calcination, but of vitrification; and with regard to the latter, inspection alone is sufficient to shew the essential difference between pumices and scoriæ.

It now remains to say a word of the opinion of M. Dolomieu, who supposes pumices to originate from granite. This naturalist having examined with the greatest attention the pumices found in the places

which I afterwards visited, especially those that had undergone the least alteration from the fire, since these are most likely to preserve some characters of their primitive base, made the following observations :

First, he found in some a residue of ordinary granite; that is, quartz, mica, and felspar; and remarked, that these three substances, which, according to him, serve, interchangeably, as a flux one to the other, had acquired, by the action of the fire, a species of vitrification of a middle nature between that of enamel and that of porcelain, and which might be compared to that of a fritt, somewhat inflated.

Secondly, he observed, that they gradually assume the fibrous and porous texture, and the other qualities of pumice; whence he concluded that the granite and granitoid schistus are the primitive substances, which, by the action of the volcanic fire, pass into the state of pumice.

On

On my first arrival at the mountain of pumices, I was, as may be supposed, desirous to ascertain the truth of this discovery ; and not being successful the first time, I returned again another day ; and this second visit proving as little satisfactory as the former, I made two others, but with the same ill success. I examined with the greatest care every corner of Campo Bianco, and every other part of Lipari where pumices are to be found ; and as it was only necessary to have eyes to discover immediately these granitous rocks, changed more or less into pumices by the action of the fire, had they existed ; I shall say, with the freedom of a philosopher, that I was frequently tempted to believe that none were any longer to be found here, because they had all been carried away by the French naturalist.

I do not, however, mean absolutely to deny the truth of this discovery (and, indeed, how can it be doubted, when M. Dolomieu asserts that he has sent to several men of learning specimens of these granites,

which have gradually passed into the state of pumice). It is consequently proved that pumices, besides having for their base the horn-stone, the asbestos, and the felspar, likewise originate from the common granite. We may likewise add the petrosilex; since the pumices formerly ejected from Stromboli derive their origin from that stone*; and if naturalists were to examine the pumices of other countries, and to their local observations join chemical analysis, it would perhaps not be difficult to find pumices which originate from other kinds of stone,

As to the pumices with a granitous base, it is obvious to remark that the subterraneous fire which produced them must have been extremely violent, since such must be that of our furnaces to reduce the granite composed of felspar, mica, and quartz, to a homogeneous consistence, similar to that of perfect pumices. Sufficient proofs of this assertion may be found in Chap. XII.

* See Chap. XI,

Proceeding from Campo Bianco by sea, and coasting the base of the mountain, we find the side lying on the left, and which is, in like manner, composed entirely of pumices, full of furrows and channels that take their direction to the sea. Other lesser mountains, which are white, because they are likewise formed of pumices, join the principal one, Campo Bianco*. Beyond these rises a mountain of another kind, called the Monte della Castagna, which, in the part of it descending to the sea, is about a mile in extent, and in its circumference exceeds four miles. But who would believe that this mountain is entirely composed of enamels and glasses? Before I had read the excellent work of the Chevalier Dolomieu, I knew that Lipari abounds in vitrifications, and the reading of this book confirmed me still more in the idea; but I was entirely ignorant that they were accumulated in such immense quantities in one place as to form an entire mountain; and I

* See Plate IX.

feel some pleasure in being the first person who has announced to the world so extraordinary a circumstance. I shall proceed, therefore, to consider these products; first, as they appear on the spot, and afterwards divide them into their species and principal varieties.

I know not to what a tract of these vitrified substances can be more properly compared, than to a large river, which, breaking into a thousand streams, dashes from height to height down a steep precipice, and, suddenly congealed by excessive cold, freezes, breaking every where into clefts and fissures, so that the precipice appears covered with a rough wavy ice, divided into large flakes. Such is the appearance of some of these vitrifications on the back of the Monte della Castagna; but seen from the shore they have a different aspect. In the places where the waves of the sea have produced deep excavations, we perceive that, under this vitreous stratum, divided into flakes or plates, there are other strata,

strata, and beneath them others, all equally vitreous, but differing in colour, consistence, and direction. Beneath these there may, likewise, possibly, be others concealed from the eye by those above them. The thickness of these strata is different; that of the uppermost in some places is not more than a foot and a half, but in others twelve feet. As it is higher than the others, it has not suffered so much from the dashing of the waves, except in its lowest parts. The higher have flowed over the rock, taking from it their configuration. These vitreous bodies, having in them numerous fissures and clefts, are easily broken by the beating of the waves, and detached pieces of them are therefore found in great quantities on the shore and under the water, but more or less rounded by the dashing of the sea, and entirely resembling those smooth irregular stones which form the beds of rivers.

I shall now proceed to describe the different qualities of the vitrified substances that compose

compose the Monte della Castagna; in which description it will be impossible to be very brief, on account of the numerous varieties of those substances, and the distinct attention which each justly claims.

I. And since the nature and qualities of pumices was the last subject that engaged our attention, I shall begin with a substance which may be considered as the point of transition of these bodies into glass. Not that it is not a true glass; but it is so light, that, like many pumices, it will swim in water, and possesses that fragility which always accompanies pumices. Hence it easily shivers when struck against steel, and rarely emits sparks. It has, besides, in more than one part, small pores, interrupted by vitreous threads, which is observable in many of these kind of stones. The vitrification is more advanced than in the pumices. The glass is of a whitish-grey, transparent, in part scaly, and in part involuted and contorted, from the number of pores which interrupt the direction of the structure.

ture. It is found in detached pieces, on the sides of the mountain; and some float in the sea, the sport of the waves.

II. This second glass resembles the former in more than one quality; but it is somewhat more heavy, and what I should call reticulated, as it contains small eyes, or spots, which give it the appearance of a net. It is found in strata above strata, and the face of every stratum is covered with an earthy and half-pulverous coating, in consequence of which coating it easily splits.

III. Capillary glass, or glass reduced by fusion to the fineness of a hair, is so rare in volcanized countries, that only four specimens of it are known to those who have most diligently examined the productions of subterranean fires. The first of these was produced by an eruption in the Isle of Bourbon in 1766, the second by Vesuvius in 1779, the third by Vulcano in 1774, and discovered by the Chevalier Dolomieu; and the fourth noticed by M. Faujas, who in

in the cavity of a basaltic lava, brought by Besson from the volcanic caves of St. Sebastian at Rome, observed a great number of capillary filaments from three to four lines in length, of a transparent and vitreous substance.

The Monte della Castagna at Lipari furnishes a great quantity of this capillary glass, which I shall consider as the third species of the substances that now claim our attention. Several of these glasses, which have a very thin texture, and are consequently very light, if they are examined internally, usually abound with cracks, sometimes extending from one end to the other of the pieces; and when struck in the direction of these they are easily split. In these vacuities, the glass is extremely small and thin; in many places as fine as a hair, and forms minute entangled filaments, resembling the finest wool, or thin threads tending all the same way. Some of the latter are so fine, that only breathing on them will put them in motion, and break them. They are transparent, and have a lustre

lustre like silver. Many of them are two inches long; and besides those which are visible to the naked eye, there are others in great numbers which are only discoverable by the lens. The nature of their formation does not appear to me difficult to explain, as it probably is to be attributed to the viscosity of the glass when in a liquid state, and the distension which took place from the enlargement of the apertures by congelation.

These thick groups of vitreous threads, when viewed by the less experienced observer, might lead him to believe that they are a species of extremely fine pumice; but a moment's attentive observation will be sufficient to discover the difference, which, as it is essential, I shall here state.

One of the sensible characters of pumices, at least of the greater part, is their being vitreous; but their vitrification is always in some degree less than that of the true volcanic glass. The filaments, however, of which I have just spoken, are entirely vitreous.

treous. In fact, they have the transparency of glass, and are smooth to the touch like that ; whereas, those of pumices are almost opaque, and rough to the touch. The latter may be safely pressed with the finger ; but the former, though thicker, enter the skin, and draw blood, as may be expected from the points and sharp edges of glass. It is true, many pumices have their original base the same with the volcanic glasses ; but the action of the fire has not been the same on both, but on the glass has either been stronger or longer continued.

Though this seems so clear in itself as to need no proof, I shall yet produce one which is extremely obvious on the comparison of some light filamentous pumices of Campo Bianco and the present glass. Both these bodies contain crystallized felspars of the same species, which in the pumices appear to have suffered no injury from the fire, as they retain their changeable lustre, their laminated structure, their natural transparency and hardness. On the contrary,

contrary, in the glass in which we find these capillary filaments, though they have not undergone fusion, they are so changed that they have lost all the characters above mentioned ; and, when touched with the finger, fall into small pieces, the larger only retaining a kind of central point of the original nature of the stone. I have in my possession one of these felspars, which presents a curious appearance. It is placed within one of these apertures, but without touching the sides, and is, as it were, sustained in the air by a crown of capillary threads of glass that are attached to it at one extremity, and, at the other, fastened to the sides of the aperture. The felspar must, no doubt, have been originally confined in the glass when it was fluid ; but this drawing back at the time of its congelation, formed the cavity, and left the felspar as it were isolated, and communicating only with that part of the capillary down, which is a part of the glass itself reduced to threads by the retiring of the sides of the cavity. This felspar, which is four lines in length, and three

in breadth, is changed equally with the rest, by the fire.

From the facts now adduced, it is evident that the fire which produced these pumices was less powerful in its effects than that from which the glass derives its origin; it is not, therefore, surprising that the latter should be more perfect than the former.

I have entered into these minute details relative to pumices and glasses, because it appears to me that the modifications and gradations visible in the operations of nature deserve the most careful attention of the philosopher, as, otherwise, by considering things too generally, we should incur the danger of confounding objects very different in themselves; as for instance, not to wander from our subject, since pumices, enamels, and glasses are vitrified substances, we might confound them together, and even not distinguish them from lavas; and, in fact, there have not been wanting eminent writers who have characterized these also as true vitrifications.

This

This remark leads me to make a few strictures on an opinion of M. Delomieu; who having observed that pumice sometimes changes into glass, imagined that this glass, by an inflation of the internal air, might pass into the state of pumice. The former I readily admit, having adduced more than one example of it in volcanic products, not to mention artificial fusions in which I have always observed this transition of pumices into glasses or enamels, which is, besides, extremely natural; the stone thus passing, by the action of a strong heat, from a less degree of vitrification to a greater. I find it, however, very difficult to assent to the latter hypothesis, as, in that case, we must suppose that a greater, or more perfect, vitrification may pass into one less perfect, which is certainly very unnatural; since glass re-melted by volcanic fire will remain in its former condition; and supposing it should be inflated with æriform gases, from solid glass, which it was before, it will become vesicular, but never, in my opinion, can it become pumice.

mice, since it cannot return to that feeble degree of vitrification which characterizes that stone. Neither are gases an essential requisite in the formation of pumices, several kinds of which are compact, and do not shew the slightest indication of these elastic fluids: besides, many glasses already mentioned, and others hereafter to be enumerated, shew, by the bubbles with which they abound, that they have every where been penetrated by these fluids, without having the least appearance of pumice.

IV. The glasses of the Monte della Castagna which we have hitherto considered, are those that have a texture more or less porous; we will now proceed to those of a compact structure, of which kind is the fourth species, which may be said to compose nearly one half of the mountain. This glass, if viewed superficially, and as it is found on the spot, has rather the appearance of a red earth than a glass, occasioned by a red earthy coating that invests the glass disposed under it in immense plates; which covering,

covering, though in many places it but feebly adheres to it, since it may be removed by simply washing with water, in others is so closely united that it forms the last rind or outermost part of the glass, which induces me to believe that it is a superficial decomposition of it. Beneath this earthy coating the glass appears, which is extremely perfect, and as if it had just come out of the volcano. If we except a few pieces in which its structure is spongy, it is extremely compact and solid, and therefore much heavier than either of the other three kinds. It is of an olive-colour, and transparent when in thin scales, examined by a bright light, but in the mass it appears opaque. It gives sparks rather plentifully with steel. Pieces of perfect glass, it is well known, when broken, have their fractures striated, waving, and curved. In this glass, some of the fractures are the same; but in general they are conchoids, like those of flints. Its consistence is not perfectly homogeneous, as it contains many felspathose points. Its aspect is not lively and brilliant, like that

of glass, but somewhat unctuous and dull. From all these qualities this product appears to be more properly an enamel than a glass; unless we are willing to consider it as one of those volcanic bodies which constitute the middle substance between enamels and glasses.

In my description of the glasses of Lipari, I have observed that several of them are intersected with veins or earthy leaves, by means of which they are easily divided into plates. The same is observable in the present glass, in which we find the same quality as in some marbles, which being cut in the vein may be divided without any great labour, into large slabs, but which break into small pieces if it be attempted to divide them in any other manner. Some of the workmen who dig the pumices, and were very useful companions to me in my excursions to Campo Bianco and the Monte della Castagna, at my request, drove, with heavy hammers, an iron wedge into these earthy veins, and extracted from the common mass of
this

this glass large plates five feet long, three broad, and two in thickness. To the surface of each plate was attached a coating of hard earthy matter, which still more confirmed me in the opinion I have already given, that this matter had resisted fusion; and, being lighter than the fluid glass, had ascended to the surface; a conjecture further corroborated by the artificial fusion which I made of this glass retaining some portion of this earth, which with difficulty fused, though the glass was inflated and changed into a frothy enamel.

This glass slightly cuts the factitious glass; and if the cutting angle of one piece is driven with force along the surface of another, it produces a white and impalpable powder.

V. This species of glass completely deserves that appellation, since it is not only the most perfect of all the volcanic glasses of the Eolian isles, but does not in the least respect yield to what is called the Iceland

agate, or the gallinaceous stone of Peru, which is supposed to have been the obsidian stone of the ancients. In the large pieces its colour is extremely black, and it is entirely opaque ; but the thin leaves are white and transparent. The opacity and blackness may be said to be in the direct ratio of the thickness. This glass, which is extremely compact, is free from æriform bubbles, and from every kind of heterogeneity. It is somewhat harder than the fourth species, and therefore cuts factitious glass more easily, and gives more sparks with steel. Its edges are sharp and cutting.

M. Faujas, having obtained some specimens of the best glass of Lipari, has made some observations on it proper to be given here. He admits that this species is the same with that of Iceland ; but he remarks, however, that it differs from it in the polish, which appeared to him more unctuous and less vitreous, besides that in the fractures it had not that waving, striated, scaly appearance, which is proper to the masses of true glass.

It

It must be remembered, however, that the specimens of M. Faujas were none of the best; the pieces, at least, which I collected, took so exquisite a polish and lustre, that I do not believe any kind of artificial glass ever received one more beautiful and brilliant. This glass, besides, when in the mass, being opaque, became a true mirror; and I therefore find no difficulty in believing that the ancient Peruvians used a similar kind of glass, cut and polished, for mirrors. This glass, likewise, could not be broken without exhibiting the undulating scales, lightly striated, which the French Vulcanist affirms he could not find in his specimens. While I now write, I have before me a piece, with a recent fracture, in which these waves are circular and concentric, occupying an area of two inches and a half, the common centre of which is the point that received the blow: they resemble in some manner those waves which a stone produces round it when it falls perpendicularly into a standing water.

I cannot

I cannot omit another remark. M. Faujas says, that the edges of this glass, where they are very thin, if presented to a strong light, are a little transparent. The transparency of the thinnest parts of the glass on which I made my observations, when compared to that of common factitious glass, is certainly not equal to it : it is not, however, so much inferior as this naturalist seems to suppose. A scale three lines and a half in thickness being presented to the flame of a candle afforded, in part, a passage to the light ; and another, two lines thick, being interposed between the eye and external objects, permitted a confused sight of them. Another, half a line in thickness, being laid on a book, it might be read with the greatest distinctness. I have entered into these minute details the better to shew the perfect quality of this glass.

The opacity of this glass in the mass proceeds from a very subtle, and, perhaps, bituminous substance, incorporated with the vitreous matter and rendering it dark like a cloud,

cloud. The glass loses this substance if it be left for some hours remelted in the crucible, and it then becomes white,

Bergman observed that the Islandic glass, when exposed to the fire, melts with difficulty without the addition of some other substance, as a flux. In this it differs from the present of Lipari, which soon begins to soften in the furnace, and in a few hours undergoes a complete fusion.

This kind of glass, however, is not the most common to be met with on the Monte della Castagna. It is found only in a few places, scattered in large but solitary masses; nor can I pretend to say, whether these are remains of currents, or whether they were thrown out by the burning gulphs.

It happens to this glass, as to the different kinds of precious stones, that is, that the same piece is not always throughout of equal purity and value; for, on breaking some of these masses, we sometimes find one

one portion very pure glass, such as has been already described, and the other imperfect; either because the fusion has not been general, the substance containing bodies foreign to the base, or because that base is rather an enamel than vitreous. These bodies are felspars, but of a new appearance. Nothing is more common than to find felspar in lavas, and sometimes even in enamels and glasses; of which we have frequent examples in this work, as well as in the accounts of other writers. But these felspars are always inserted immediately into these substances without any intervening body. Here, however, the case is different: every felspar is surrounded with a rind or coating, which, when it is extracted entire from the enamel, appears to be a vitreous globule, about one or two lines in diameter, of a clear cinereous colour. If we break this globule, we find within it the half-fused felspar, not divested of its coating, but forming one body with it. These globules are very numerous, and sometimes by their confluence form groups; and they
are

are very distinctly visible, on account of the black colour of the enamel.

The manner in which this coating was formed around the felspars, I conceive to be as follows: When the enamel was fluid, and enclosed the felspars, it acted as a flux to their external parts, and combined with them; and from this combination was the rind or coating produced, while the internal part of the felspars had only undergone a semi-fusion, because it was not in immediate contact with the enamel. There can be little doubt but that the felspars likewise existed in the perfect glass; but the heat probably being more active in that than in the enamel, they were completely dissolved, and the entire mass reduced to one similar consistence. As a proof of this conjecture, the furnace produced a complete homogeneity of parts in the enamel containing these extraneous globules.

VI. When treating of the rocks of the Castle of Lipari, I said they were formed of

a cinereous lava of a felspar base, which in many places has passed into glass. I, likewise, remarked that the lava, as well as the large pieces of glass, was filled with globules apparently not dissimilar to the base. At the beginning of the Monte della Castagna, not far from a cottage, the habitation of one of the labourers who dig pumice, there is a current of similar glass that falls into the sea in several branches, and which I shall here consider as the sixth species. This glass, however, has a more fine and shining grain, and its fracture is exactly such as we observe in glass; yet in beauty it is little inferior to the fifth kind; and if whiteness, or, more properly, the want of colour, is particularly valuable in volcanic glasses (since those which have this quality are extremely rare), this, certainly, has considerable claim to our attention. Not that it is entirely colourless, as it contains a kind of obscure cloud, which gives it, when viewed in the mass, a blackish hue; but at the edges it appears white. The round cinereous bodies with which it is filled, form the

the most pleasing and conspicuous contrast, and render the glass irregularly spotted. I have large pieces of the fifth sort cut and polished. Their colour, which is that of pitch, gives them a peculiar beauty. The blackest and choicest marbles of Varenna and Verona are far inferior to them in fineness of grain and lustre; yet, from their uniformity of colour, they are less beautiful than this spotted glass, when it has received a delicate polish from the hands of the artist. On the shore, where the torrent fell into the sea, we find pieces of all sizes, rounded and smoothed by the continual agitation of the sea; I have met with more than one of half a foot and a foot in diameter. Notwithstanding the powerful action of the waves, which have beaten on them for so long a time, their internal parts are not injured, and, when cut and polished, they present surfaces very beautiful to the eye. Tablets of this kind of glass (and there is no want of pieces of a proper size to form them) would add much to the grandeur and splendour of any sumptuous gallery.

But

But disregarding the beauty which delights the eye, let us proceed to objects that attract and interest the curiosity of the philosophical enquirer. We shall find that the cinereous bodies included in this glass are only points of lava with a felspar base; and on examining, in various places, the current of this glass, we shall perceive that it is a continuation of the same lava with the felspar base, of which these orbicular corpuscles are composed; whence we shall not hesitate to conclude, that from this stone, both the lava and the glass derive their origin, and that we find small particles of lava scattered through the latter, because it has not undergone complete fusion; whence we find some pieces composed partly of glass and partly of this same lava. In some of these pieces we discover small geodes, or thin filaments of an extremely brilliant and transparent glass resembling in miniature the hulk of the chestnut.

VII. Though this glass in many particulars resembles the last species, it yet differs from it in others. It is perfect like that;
but

but it is of a deeper colour. In it, likewise, the small globules abound; but they are earthy, and pulverizable; every one is detached in its distinct niche, or at most is only fastened to it by a few points.

The description of this seventh species of glass will render that of several others unnecessary, since the glasses I should have to describe contain a greater or less number of similar globules, differing only in the nature of the base inclosing them, which in some is more, and in others less vitreous. I shall only make one observation, which I think to be of some importance, relative to the glasses I here omit. Several of them have, even in their internal parts, fissures frequently an inch in breadth and three inches in length. These are not entirely vacuities, but are frequently crossed by small threads of glass connected at their two extremities with the sides. The broadest of these threads are four lines in breadth, and the narrowest scarcely a line. When broken they have the fragility of glass, and are

found to be a most perfect glass, being colourless, and extremely transparent. It is easy to conceive that these threads have been formed in the same manner with those of the capillary glass found in similar fissures in the third species of glass.

VIII. The eighth and last kind of the vitrifications of the Monte della Castagna, may be denominated an enamel that has the colour and lustre of asphaltum, of a scaly grain, a very small degree of transparency in the points of the fractures, and of considerable weight and compactness, though it is extremely friable. It is found in solitary masses, not very numerous, and the broken pieces have the property of assuming a globose form. Some of these globes resemble those found by M. Dolomieu in the island of Ponza. I have been favoured with two of the latter by the Abbé Fortis; but I find, that, excepting their globose figure, they differ in every respect from those of which I now speak. The globes of Ponza are composed of leaves over leaves, of

of an imperfect enamel, do not give sparks with steel, and contain felspars and mica; whereas these of the Monte della Castagna rarely include a few felspars, give sparks with steel, have a vitreous appearance, and are not composed of plates or leaves.

Some pieces of this enamel, broken and detached from the masses, are in one part true enamel, and, in another, lava. The latter gives few sparks with steel, has a grain approaching to earthy, and, as far as I could discover, has for its base a soft hornstone, from which, consequently, the enamel, likewise, derives its origin.

These are the principal vitrifications I observed in my excursions to the Monte della Castagna. Some I have omitted to notice, since, some trifling differences excepted, they are essentially the same with those described. It is proper, however, to remark, that more than one of them exhibits manifest signs of having once flowed down the sides of the mountain, in

the thick threads and vitreous filaments they contain, similar to those we see, on a lesser scale, in glass fused in our furnaces, when it comes into contact with the cold air, as it flows down an inclined plane.

Every one of these eight kinds of glasses and enamels may be completely re-melted in the furnace. When speaking of the compact glass of the Rock of the Castle of Lipari, I remarked its extraordinary inflation in the furnace, and said that this tumefaction usually accompanies a re-fusion, in our fires, of solid glasses, and volcanic enamels. I then had in view those of the Monte della Castagna, five of which, though compact and solid, in the furnace, swelled high above the edges, notwithstanding that, before their re-fusion, they only filled a third part of it. In the description of other glasses of Lipari, I shall have occasion again to remark the same phenomenon, on which I shall make further observations in another part of this work.

Let

Let us now proceed to consider the most remarkable lavas of the same place, which have an immediate relation with the glasses and enamels, from bearing some characteristic impress of vitrification. I then flatter myself I shall have given a sufficient detail of the volcanic products of this famous mountain.

The first species I shall describe has for its base the petrosilex; is hard and compact, and proportionably heavy, of a siliceous aspect, of a pale blue colour, giving sparks with steel, and abounding in black, rhomboidal, well-preserved shoerls. When it was in a state of fluidity, it enclosed within it several bodies of a different nature from itself; which being angular, and having sharp edges, shew that at the time they were included in it they were not in actual fusion. Their colour, which is that of baked brick, their numerous fissures, and their fragility, incline me to believe that they have been calcined, probably when they were taken up by the current.

This lava is spotted, and, in many places, even veined, with a black and opaque enamel, harder than itself, but which gives but few sparks with steel. Its aspect is between the filiceous and the vitreous, and it has great compactness. The shoerls it contains are unaltered. This lava is disposed in strata, and extends a considerable way in some of the hollows of the mountain.

The extreme blackness and homogeneity of the enamel into which this lava is changed in the furnace, prevents the eye, at the first view, from discerning the shoerls it contains; but they are discoverable with the lens. They have lost their crystallization, and have assumed a globose figure, a certain mark of fusion, and their black colour is tinged with a dead green. The refusion shews that this lava contains a number of felspar scales, which I at first could not discern even with the aid of the lens. Their white and somewhat changeable colour renders them visible on the extremely black ground of the remelted enamel.

The

The second lava is of a felspar base, partly white, and partly of a reddish yellow: it has a lucid grain, and includes amorphous felspars, unequally distributed, being rare in some parts and abounding in others. In many places, it is a true glass, distributed in small masses of various colours, some black, others cinereous, and others white: the latter is as transparent as factitious glass.

This lava is rather rare; at least I only met with two pieces of it, about the middle of the mountain; and from their angles and fractures I judged that they had been detached from some larger mass.

It is one of the very few kinds which melt with difficulty in the furnace; but it is at length reduced to a black porous enamel, but without the fusion of the felspars.

The third lava is of a grey colour, hard, compact, heavy, rough to the touch, and granulous. It has for its base the petro-

filex, and gives vivid sparks so copiously with steel that it may supply the place of flint. When viewed in the dark by the light of a candle, it shines so brightly in a number of points, that, at first sight, we might be induced to believe that it was full of small crystallized and extremely brilliant zeolites, or little lucid shoerls; but on more attentive examination we discover, especially in the recent fractures, that these points are only small particles of glass, scattered in great abundance through its whole substance.

On one side of the Monte della Castagna there are prodigious masses of this lava, but in detached pieces, which leave us in uncertainty with respect to its origin.

In the furnace, this lava produces a black homogeneous enamel, compact, and slightly transparent in those parts of the edges which are thinnest.

The fourth species has a felspathose base, and likewise contains a number of vitreous particles,

particles, but which approach rather to the nature of enamel than to that of glass.

As this lava is extremely white, we might at first be induced to suspect that it has been decomposed by sulphureous acids; an opinion which its friability appears to confirm. But there is more than one reason to convince us of the contrary. First, the injury which this lava had received from these acids would have extended to the enamel, as I have shewn that the enamels and vitrifications of Vulcano are sensibly altered by these volatile salts, whereas the present enamel is not at all affected. Secondly, as these vapours act on the surface of volcanic productions, the decomposition and whiteness do not usually enter very deep into them; and the nucleus of these products retains its colour and primitive compactness. An example of this we have already noticed in the lavas of Solfatara and its environs*; and we shall soon have occasion to mention

* See Chap. II.

another

another in those of Lipari, not far from the Stoves, or hot baths. The present lava, however, which is in detached pieces, many feet in thickness, has the same whiteness and friability on its surface and in its most internal parts. Lastly, these vapours, in decomposing volcanic products, take away the roughness of the parts, and render the surface smooth and more or less soft to the touch; but this lava retains the same roughness in every part. I must here add, that, in all my researches about the Monte della Castagna, I have not found any part of it which shews signs of the influence of these sulphureous vapours.

The furnace, in a few hours, reduces this lava into a gross enamel, of little adhesion, and of which many parts are not vitrified; but, in a longer time, it passes into a true homogeneous and extremely porous glass.

The fifth and last lava may be considered in many different points of view, each of which deserves to be distinctly noticed; the
fire

fire and elastic fluids having produced very different qualities in the same product. The following are the principal :

If we break a mass of this lava into several pieces, we shall find that some of them have many cracks or fissures; some extending lengthwise, and which seem to have been produced by the retiring of the parts on congelation, and others of a roundish form, probably the effect of the action of the elastic gases. These fissures are surrounded with fibres, knotted and twisted in a thousand ways, and resembling those found in the cavities of some kinds of pumice; except that the fibres of the latter, the finest at least, have the lustre and colour of silver, whereas the seare of a dark grey, and a structure not at all vitreous.

Other pieces of the same lava have not these fissures, and differ from the former likewise in other respects. Those before described are light, and have a sponginess similar to that of some burnt bones, as also

great friability; whereas, on the contrary, these are compact, hard, heavy, and contain small and shining particles of glass.

Others instead of these particles or points have a vitreous ground, but scattered over with small globules of lava.

Lastly, others have passed into glass which would be very perfect were it not mixed with the above-mentioned globules.

The colour of this lava, where there are no vitreous parts, is cinereous; and its base, as far as I can discover, horn-stone. In the furnace it produces a scoriaceous enamel.

Having thus described the principal volcanic products of Campo Bianco and the Monte della Castagna, which are pumices, glasses, enamels, and lavas, more or less vitreous, I shall here make a few remarks, before I proceed to describe the other objects that drew my attention on the remaining parts of the shores of the island.

Though

Though Campo Bianco and the Monte della Castagna are considered as two distinct mountains, they are so connected together and continued that they may very justly be esteemed only one; or at least as forming a single group in the island. The identity of the products in both, confirms in some measure the unity of this group. In the part abounding with pumices, we meet, at every step, with detached pieces of glass, and on the Monte della Castagna amid the glasses we find numerous pumices; a part of the solid kinds of which are dug here after removing the masses of glass under which they are buried.

It is further to be observed, that though this mountainous group when seen from the sea appears isolated, yet, on ascending to the summit, we find that it extends far to the west, as we shall perceive more distinctly when we come to treat of the Stoves of Lipari. I believe, therefore, I should not exaggerate were I to say that this group of mountains, taken in its whole extent, has a circuit

circuit of eight miles ; nor is the extent of its vitrifications less, if in these we include likewise the pumices, which are, in fact, only a less perfect glass.

But how much more extensive, on the side of the sea, must have been this tract of vitrified substances in the ages immediately following the formation of the island ! We have already seen how the rain-waters, that drain toward the sea from the summit of Campo Bianco, have deeply corroded and furrowed its declivity. The ravages which the waves of the sea have made, and are continually making, have already been described, and are sufficiently proved by the heaps of pumices fallen along the shore, and those which float on the waves at the foot of Campo Bianco ; for neither a north nor a north-east wind can blow without a prodigious quantity of these light stones being waisted into the harbour of Lipari.

The devastations which the vitreous mountain della Castagna has suffered and is daily

daily suffering on the side beaten by the sea, are likewise very great. That these have formerly been very considerable, is proved by the small vitreous rocks within the sea, which there is no doubt anciently formed one whole with the mountain, and have been separated from it by the corrosion and destruction of the intervening glasses.

In this extensive group of mountains and their environs, we find no characteristic marks of the existence of ancient craters. It is true that in several places we find cavities that approach to a round form; but they leave us in absolute uncertainty whether they have been mouths of volcanos, since we meet with similar ones, and much more specious, in countries not volcanized. It cannot, however, be doubted, that Campo Bianco and the Monte della Castagna are the produce of successive eruptions, some of which have formed currents, and others been thrown into the air. Of the former we have seen many proofs both in the pumices

mices and the glassess; and the detached and solitary pieces of these same substances are sufficient evidence of the latter.

With respect to the glassess, besides those which are scattered solitarily on the Monte della Castagna, we meet with them dispersed in like manner on Campo Bianco. The ejections of these substances from the volcanos have likewise extended beyond these places, as I began to find them scattered among the lavas before I arrived at Campo Bianco. We have also seen that some kinds of the pumices bear evident marks of having been thrown into the air from the volcanic gulphs. This I now judge to have been the origin of the pulverized pumice with which Campo Bianco abounds. I at first imagined it was to be attributed to the superficial corrosion of the rain-water, and the influence of the atmosphere; but in more than one deep excavation made on the spot, where either the rains have not penetrated, or, if they have, must have been unable to corrode,

corrode, from want of impetus, I found the same abundance of pulverized pumice: I am therefore of opinion, this must have been thrown out by the same volcano that ejected the pumices. Such, in fact, is the constant effect observable in burning mountains; which, when they eject lavas and other ignited bodies, throw out, at the same time, clouds of ashes, which, when attentively examined, are found to be only a mixture of small particles of the larger bodies ejected. I have made the same observation relative to the fiery showers of Vesuvius and the ejections of Stromboli.

We have seen that the primordial rocks, which, by their liquefaction, have given birth to Campo Bianco, the Monte della Castagna, and the vast rock on which the castle of the island stands, were for the most part felspar or petrosilex, sometimes converted into pumices, sometimes into glasses and enamels, and sometimes into mixed lavas containing more or less vitreous parts. In describing these vitreous parts, and the

large masses of glass that are a continuation of the lavas, I have not attempted to determine whether it has been the consequence of a more vehement heat, that the lava has in some places been changed into glass, or because that in some parts it was more easily vitrifiable. Both opinions appear probable, and possibly both may be true, according to the difference of circumstances. Where a lava retains the nature of lava for some extent, and then changes into glass, I find no difficulty in supposing that its vitrification has been the consequence of a more intense heat: but wherever large masses of lava exhibit points of glass, not only externally, but even deep in their interior parts, it does not seem very natural to suppose that these can have been the effect of a stronger action of the fire upon those points of the lava; they must rather be ascribed to a greater aptitude in the lava itself to vitrify in those parts.

And here an opportunity presents itself to mention an appearance I observed, which
certainly

certainly merits some attention. In making the circuit of the sides of Campo Bianco, and the Monte della Castagna, I sometimes met with isolated masses which any person without the least doubt would have pronounced to be glass, as in fact they were externally, this glass inclining to a yellow or blue colour, being very smooth, and promising to prove extremely fine. But on breaking one of them it was found to be a pure and simple lava, coated with a slight varnish of glass, like the glazing of an earthen vessel. I at first imagined that the heat had acted more powerfully on the surface of these lavas when fluid, than on their internal parts: but a further examination convinced me this supposition was ill founded; for more than one of these masses were angular, and in some places discovered old fractures which sometimes had a conchoidal figure. I could also, sometimes, join two pieces together in such a manner as to prove that they had once formed a larger whole. In these cases the vitreous varnish, which was about the thickness of 1-6th of a line,

was equilly extended over the angles, the fractures, and even the surfaces by which the two pieces might be so exactly joined. It was impossible, therefore, not to conclude that this varnish had been produced posterior to the action of the fire. But by what cause? I candidly confess I know not: I can only say, that on examining volcanic glasses on the spot I have found that some of them, in the parts most exposed to the action of the atmosphere, and the elements, have contracted a kind of opal-appearance, extremely agreeable to the eye, but entirely superficial. May not the same cause, whatever it be, which gives this pleasing polish to glass, by acting on the lava, cover it with a vitreous varnish? I shall not, however, venture to determine any thing positively.

I shall conclude my observations on these places with some remarks on the universal sterility that reigns through them, though their origin is anterior to the records of history. If we except a few lichens attached to the fissures of the glasses, there is no vestige

vestige of a single living vegetable over the whole Monte della Castagna; and on Campo Bianco, as has before been said, they are extremely rare. This sterility is a consequence of the vitreous nature of the mountain, which, in so many ages, has not been decomposed into a vegetable earth, and, according to every appearance, will continue the same for a long series of centuries to come. Among all volcanic products, the vitrified substances are the most refractory to the changes of the atmosphere and the action of the humid elements. This simple observation may teach us how uncertain are all attempts to determine the epochs of the flowing of lavas from the greater or less change they may have suffered from the influence of the atmosphere combined with that of other destructive agents; the degree of such alteration depending on the nature of the lava itself, according as it may be more or less earthy, or more or less vitreous. We may, indeed, with the utmost reason, ascribe an antiquity almost transcending our conception, to a volcanic glass, or a vitreous

lava, which shall naturally have been reduced to an earthy soil, proper for the production and nourishment of plants.

The abundance of the objects presented by this side of the island of Lipari, has compelled us to be somewhat diffuse ; but this it was impossible to avoid, without failing in accuracy. This prolixity will, however, be compensated, by the brevity with which the other productions of the base of the island may be described ; since, though we have scarcely examined more than a third part, the remainder offer only a few facts deserving observation.

Beyond the pumices, the lavas again appear, beginning from the *Punta del Segno Nero*, and extending in a chain of several miles, which on the side of the sea descends in precipices and craggy declivities. These lavas, with respect to their composition, will not greatly attract the attention of the Volcanist, since in that they do not differ from those of other volcanos ; they will only ex-

cite his notice for their currents, which in some places descend separately, and in others intersect, and pass over each other. For the extent of three miles they do not appear to have suffered any alteration but that which is the effect of the atmosphere, and which in them is extremely small; but when we arrive opposite to Saline, and tack the boat towards the Strait of Vulcano, we find them all more or less decomposed by sulphureous acid fumes. They present a highly varied scenery, from the diversity of colours they exhibit; among which the red and white are most conspicuous. On a nearer examination they are found soft, and some of them pulverizable; but the decomposition only reaches to a small depth; these lavas still preserving, in their internal parts, their hard grain, and natural compactness. Several of them are covered with a crust of sulphate of lime (selenite).

The lavas thus changed by the action of these salts, extend only from the sea-shore to

the part opposite Vulcano ; leaving, however, some intervening vacancies. Such is that denominated La Grotta della Signora, formed by a spacious incurvation of the shore hollowed out of the lava, which may be termed a breccia, since it is composed of a number of angular and irregular pieces of lava of a petrosiliceous base, united together, and which, not being extremely solid, has easily been broken and excavated by the action of the waves.

Proceeding farther, we find the sea make an incurvature, and form a small bay called the Valle di Muria, which, from the interesting objects it presents, merits to be somewhat particularly described. On its sides rise high and steep rocks of lava, half demolished, the fallen pieces of which lie in heaps on the shore. In several places this lava exhibits no traces of having suffered any alteration from the action of the sulphureous acids ; but in others a decomposition very sensibly appears ; nor is it wanting in incrustations of sulphate of lime, of a red
tinge,

tinge, though some remain very white. But neither in these places, nor in others before mentioned, do these fumes any longer act, no smell of sulphur is perceived, nor any vapour seen; and it is probable that all remains of internal conflagration have long since been extinct.

Among these lavas we likewise find enamels and pumices. Sometimes the former are separated from the latter, and sometimes one part of the same piece is pumice and the other enamel. The latter is opaque, of a cinereous colour, friable, of a scaly grain, and, as I judge, of a petrosiliceous base. The pumice is of the class of the compact and heavy, and of a filamentous grain. Both the pumices and enamels frequently contain felspars, though scarcely discernible, and some scales of black shoerls.

Both these bodies produce in the furnace a black enamel, with many bubbles in that afforded by the enamel, but fewer in the product of the pumice: the shoerls and felspars fuse in both.

Among

Among these decomposed lavas we meet with certain curious and beautiful objects, which derive their origin, in my opinion, from filtration. Two of these I will describe, after having given some idea of the lava in which they are observed.

This lava is white, friable to a certain depth, and manifestly shews a decomposition by sulphureous acids. It is of a petrosiliceous base, in many places disposed in strata; and its stratification is probably that of the stone from which it originated. It is full of small cells, and other minute cavities, within which the objects I mentioned make their appearance.

The first of these consists of minute crystallizations of shoerls. From the internal sides of several of these cells and cavities project very slender shoerls, which form sometimes a kind of plume, at others a fan in miniature, at others a truss or bunch, and at others they are detached, and, when viewed with the lens, resemble minute bristles of a dark

dark chesnut colour. A similar appearance I observed in the fissures of a lava of Solfatara *. I am of opinion it is to be ascribed to filtration, after the hardening of the lava; since, though it is certainly very common to find shoerls in lavas, they are always found incorporated within them, in the same manner as they existed in the stone, their original matrix, and never detached from the lava, as in the present case.

The second filtration has produced small quartzose crystals; and the manner in which they are distributed in the lava, and their prodigious number, render them a very singular phenomenon among volcanic objects. Wherever the lava is scabrous, wherever it has folds, sinuosities, cavities, or fissures, it is full of these crystallizations. The larger crystals extend to three lines and a half in dimension; but these are extremely rare, and almost always ill-formed. The greater part are about half a line. When we view a piece of this lava exposed to the sun, it

* See Chap. II.

sparkles in every part ; but on a more attentive examination we discover the single, minute, quartzose crystals, which may be discerned still more clearly by the aid of a lens.

These crystals generally consist of an hexagonal prism, infixed by the lower part into the lava, and, in the upper, terminated by an hexagonal pyramid, the sides of which are for the most part isosceles triangles. The form of these pyramids, however, is not always the same, neither with respect to the number nor the figure of the sides, and the same is to be observed of the prisms. Three crystals alone, among the great number I examined, were terminated by two pyramids: the prism was attached to the lava in a few points, and the pyramids projected out. This kind of crystals is extremely brilliant, and of the first water. There is scarcely one which is not streaked transversely like rock crystals. The most regular are in small cavities, without, however, entirely covering the sides of them, as
is

is usual with the geodes. Not a few of them, likewise, are found out of these cavities, in some parts of the lava : these are frequently short and grouped, not without some confusion of the prisms and pyramids.

The lava which is embellished with these crystallizations, forms immense rocks, and vast elevations hanging over the sea, which, wherever they are broken to a certain depth, are found to contain these crystals, accompanied by capillary shoerls, such as have been already described; but the latter are not very numerous.

It is well known that rock crystals sometimes contain within them extraneous bodies, such as small tufts of amianthus or asbestos, metallic sulphures, earthy particles, and even crystallized shoerls of various sizes. I have in my possession a group of needle-formed crystals, from Mount St. Gothard, within which are seven small prisms of black and striated shoerl. The same may be observed

served in these minute crystals; relative to the capillary shoerls, as will appear from the following facts: First, I have found in a fissure of the lava, a quartzose crystal, containing a group of capillary shoerls, in part included within it and partly projecting out. Secondly, the apex of a similar group or tuft projected from one side of the same piece of lava, and buried itself, with extended threads, within the pyramids of three crystals that formed a knot. Thirdly, one crystal was perforated from side to side by a needle of shoerl, the two ends of which projected out; and many similar needles projected from the surface of another crystal. I might produce many other instances of these sports of nature equally curious; but these appear to me sufficient to prove my assertion, as also another truth, which is, that the formation of these capillary shoerls must have preceded that of the quartzose crystals; otherwise it is impossible to conceive how the former should have penetrated the substance of the latter.

I have

I have generally experienced that the decomposition of lavas was an obstacle to their perfect fusion; and this was the case in the present lava. In the furnace it vitrified superficially, with some beginning of internal fusion; but the pieces still preserved the form they before had. Having broken several of these pieces, I examined the cavities, which, according to the preceding observations, must contain the crystals of which I have been speaking. I, in fact, found them there, and, to my great surprise, perfectly unchanged; as I could not discern, in either the prisms or pyramids, the slightest flaw or scratch, and they even retained their brilliancy and transparency. I observed that some of them had been overflowed, if I may use the term, by the lava superficially re-melted, to one third or a half of the prism, and some of them quite to the base of the pyramid; but the part which rose above the lava, was perfectly well preserved. Very different was the case with the shoerls, which, by their melting, had left blackish spots on the lava, though in more than one

of

of these the traces of the shoerl might still be distinguished.

A third stone, the origin of which I likewise ascribe to filtration, is a semi-transparent calcedony, of a milky whiteness, with a slightly blueish cast. It is found in reniform, or kidney-shaped, pieces, within the lavas of the above-mentioned Valle di Muria, and still more plentifully on the sea-shore. The smallest are an inch in diameter, but the largest eight, and some twelve inches. There are few of them which have not knobs and cavities; the latter commonly form geodes of minute quartzose crystals, but of which little more is discernible than the pyramid. It is well known that calcedonies differ very much in hardness. The present are extremely hard, and, from the strength and quantity of the sparks they give with steel, equal the best flints. They will likewise cut factitious glass; but in this they do not excel the small quartzose crystals produced by filtration, of which we have just spoken.

On

On breaking some of these calcedonies, one of them was found to contain two extraneous bodies ; that is, a small piece of lava and some sulphate of lime crystallized ; which were probably taken in by the particles of the calcedony, while in a state of fluidity or softness.

These substances, which are found on and within the lavas, and are foreign to them, derive their origin, in my opinion, from their decomposition caused by the sulphureous acids, or even by the injuries of the atmosphere. The coherence of their constituent parts being destroyed, particles of them are carried away and deposited by the water in the cavities and fissures of the lavas, where, from the affinity of aggregation, they produce stalactitical concretions of different kinds according to their respective natures. If the lapidarious moisture be a mixture of silex, alumine, magnesia, lime, and iron, in certain proportions, it will crystallize into shoerls ; or if it be entirely or principally siliceous, it will produce quartz-

ose crystals. If again this moisture, in which the flint is so abundant, contain, likewise, a small quantity of alumine, it will consolidate into masses of calcedony, which will take the form of the cavities that have received the moisture.

This latter stone has been discovered in other lavas. Such are the Vicentine, called *Enidri Vicentini*, from the drops of water which they sometimes contain. My specimens have none; but I doubt whether any have been found equal to them in size in volcanic countries. In some of them, their milky whiteness is interrupted by rose-coloured spots; which colour is probably derived from the iron that tinged the lava before its decomposition.

Before I conclude this Chapter, two things more remain to be mentioned, which I observed before I returned to the haven of Lipari, which is distant about three miles from the Valle di Muria.

First,

First, there are two rocks within the channel of Vulcano ; one nearly of a triangular shape, a hundred and fifty-two feet high, and twenty in breadth. It is called Pietra Lunga, and is remarkable for a kind of gate in the middle of it, through which small vessels may pass. The other is of the same height, but has greater breadth, and is about two hundred paces distant from the former. The matter of which both are formed is the same ; that is, a decomposed lava, of a petrosiliceous base, and extremely resembling that of the Valle di Muria, which contains the quartzose and shoerlaceous crystallizations ; though in this none are to be found. The lavas of Lipari extending along the shore, in front of these two rocks, are partly of the same quality, which inclines me to believe that anciently these lavas formed one continued whole with the two rocks, though the former is distant from them two hundred and forty feet, and the latter a full mile ; and, therefore, that the channel which separates Vulcano from Lipari, and which is but narrow,

must, once, have been much narrower. I have, likewise, frequently observed, when the sea has been perfectly calm, rocks under water, between the two above-mentioned and the shore of Vulcano; whence it appears to me not improbable that this island was formerly united to Lipari, and that the incessant beating of the waves has in time formed this channel or strait, in the same manner that many other straits, of much greater breadth, have been produced by the sea.

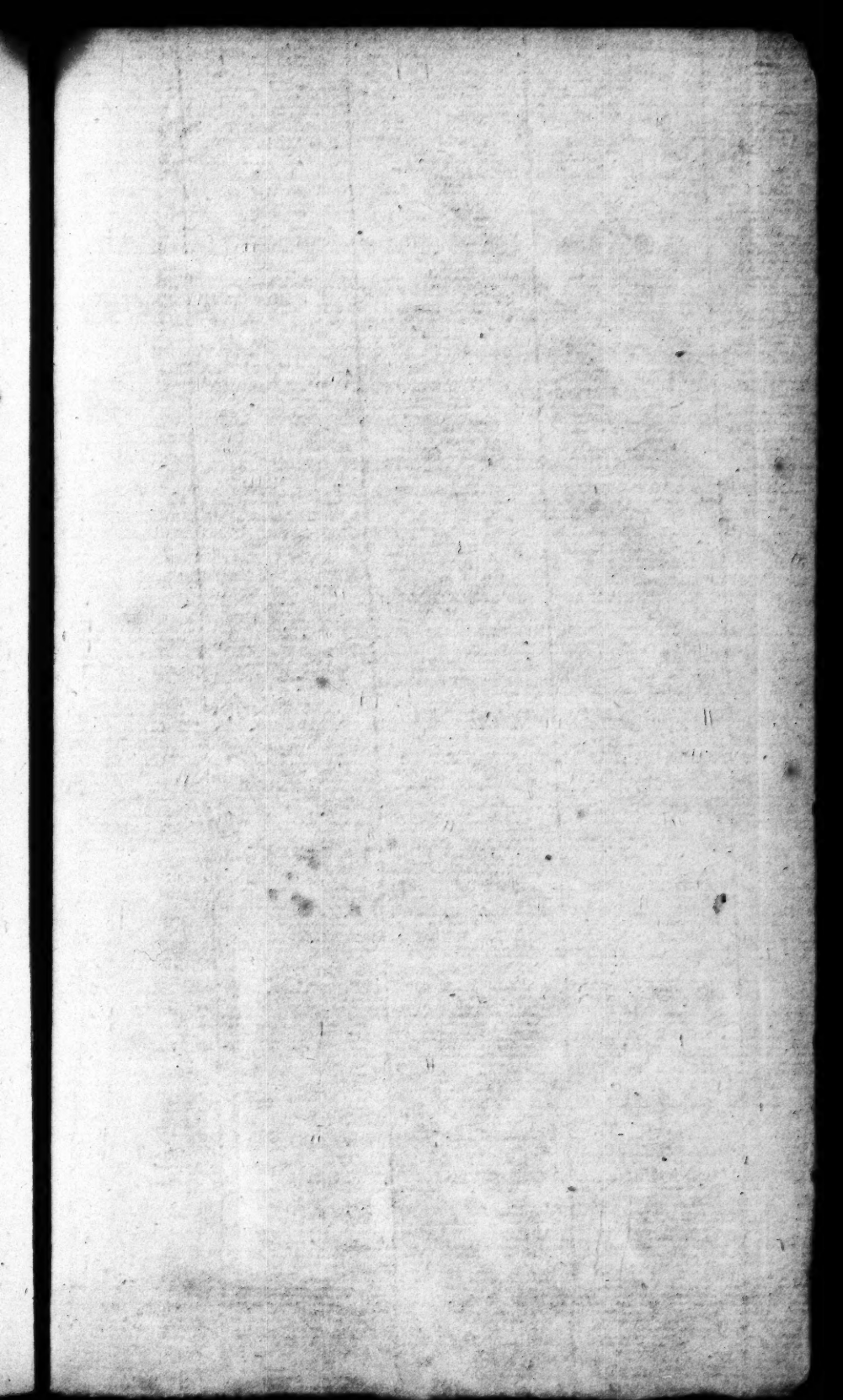
The second observation I had to make respects the appearance of Monte della Guardia as seen from the sea. It there appears bifurcated, from the projecting of a much smaller mountain, called Monte Gallina, from its north-east side. The roots of Monte della Guardia, on the south and south-east side, are in the sea; and some parts of them afford pumices, which higher up are buried under vast accumulations of lava that has flowed over them. Besides the pumices, several of these lavas, in the direction

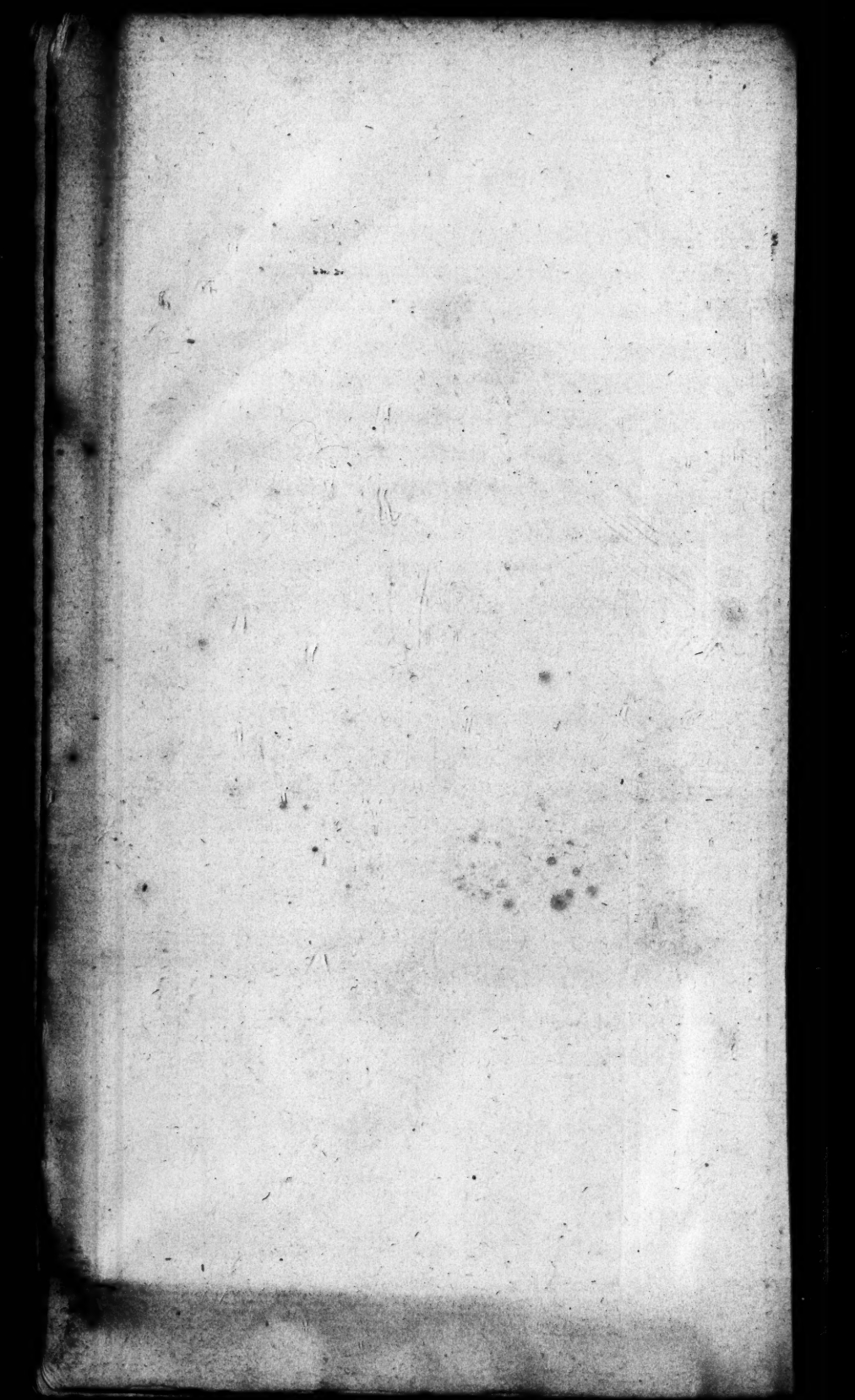
rection of the south-west, present large masses of glass, partly detached, and partly incorporated within them. If to these two kinds of vitrifications we add the others which lie under the Castle of Lipari, and on its sides, and which make a part of the base of the Monte della Guardia, we shall perceive how much this mountain must have abounded in vitreous eruptions; an abundance which will appear still greater when we come hereafter to consider its more elevated parts.

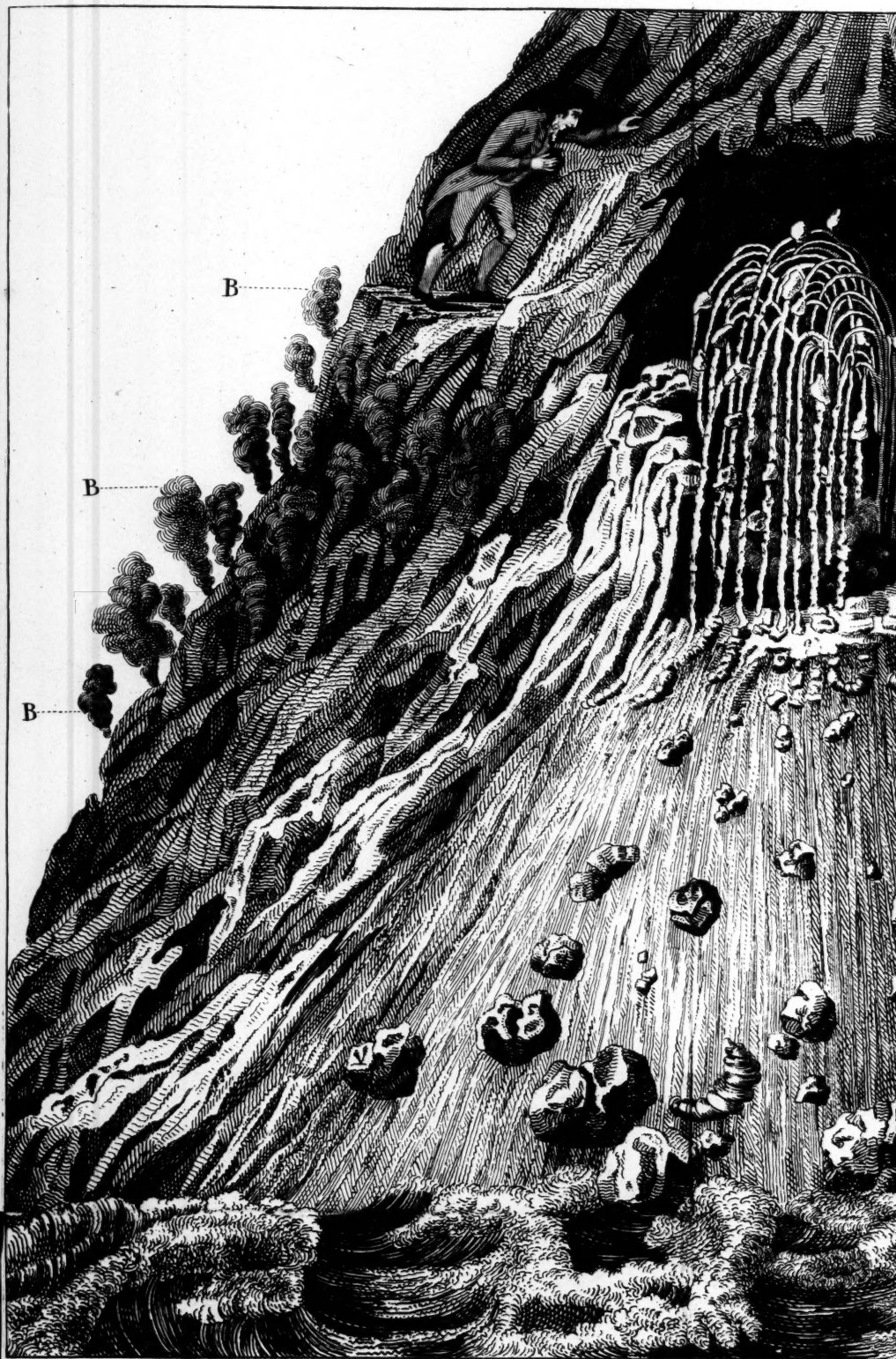
These are the most important objects which presented themselves to my observation in my excursion round the base of Lipari; and if in describing them I may appear to have been somewhat too diffuse, their number and importance, and my desire to give the reader an accurate idea of them, must be my excuse. The interior part of the island, which I shall now proceed to consider, will afford me an opportunity to be more concise.

region of the South-west, present in the
of this party detached, and partly in-
posed within them. It is these two kinds
of variations we add the others which he
under the title of *light*, and on his side,
and which make a part of the half of the
the *light* of the *light*, we shall perceive how
much this movement must have abandoned
in various positions; an abundance which
will appear still greater when we come here
after to consider its more elevated parts.

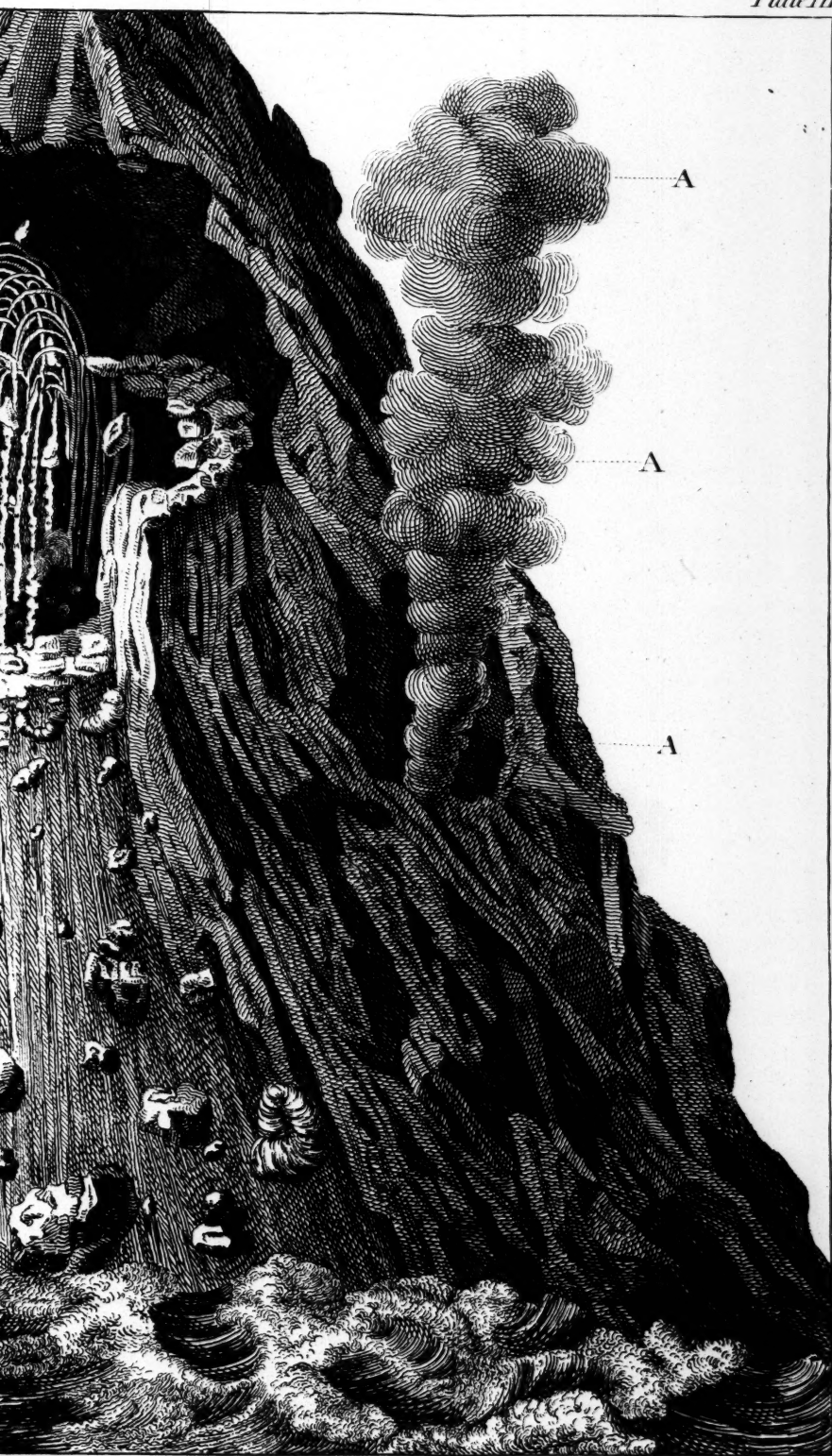
These are the most important objects
which present themselves to our observa-
tion in the present state of the half of the
part, and it is observed that the half of the
part to have been the same as the whole.
The number of the half of the part is
five or six, and the number of the whole
is ten or twelve. The number of the
of the half, which is the same as the
of the whole, will be the same as the
of the whole, which is the same as the
of the whole.

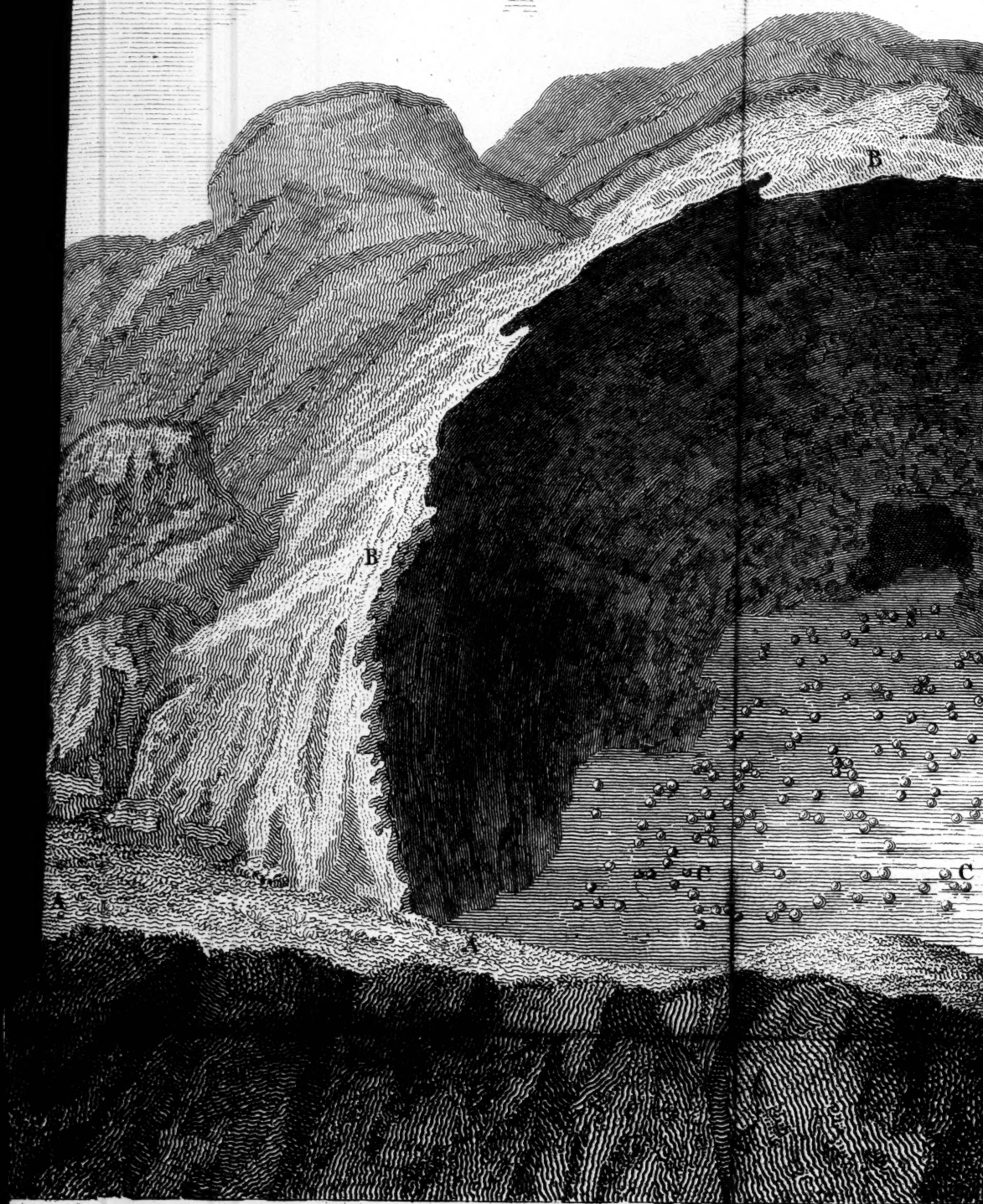




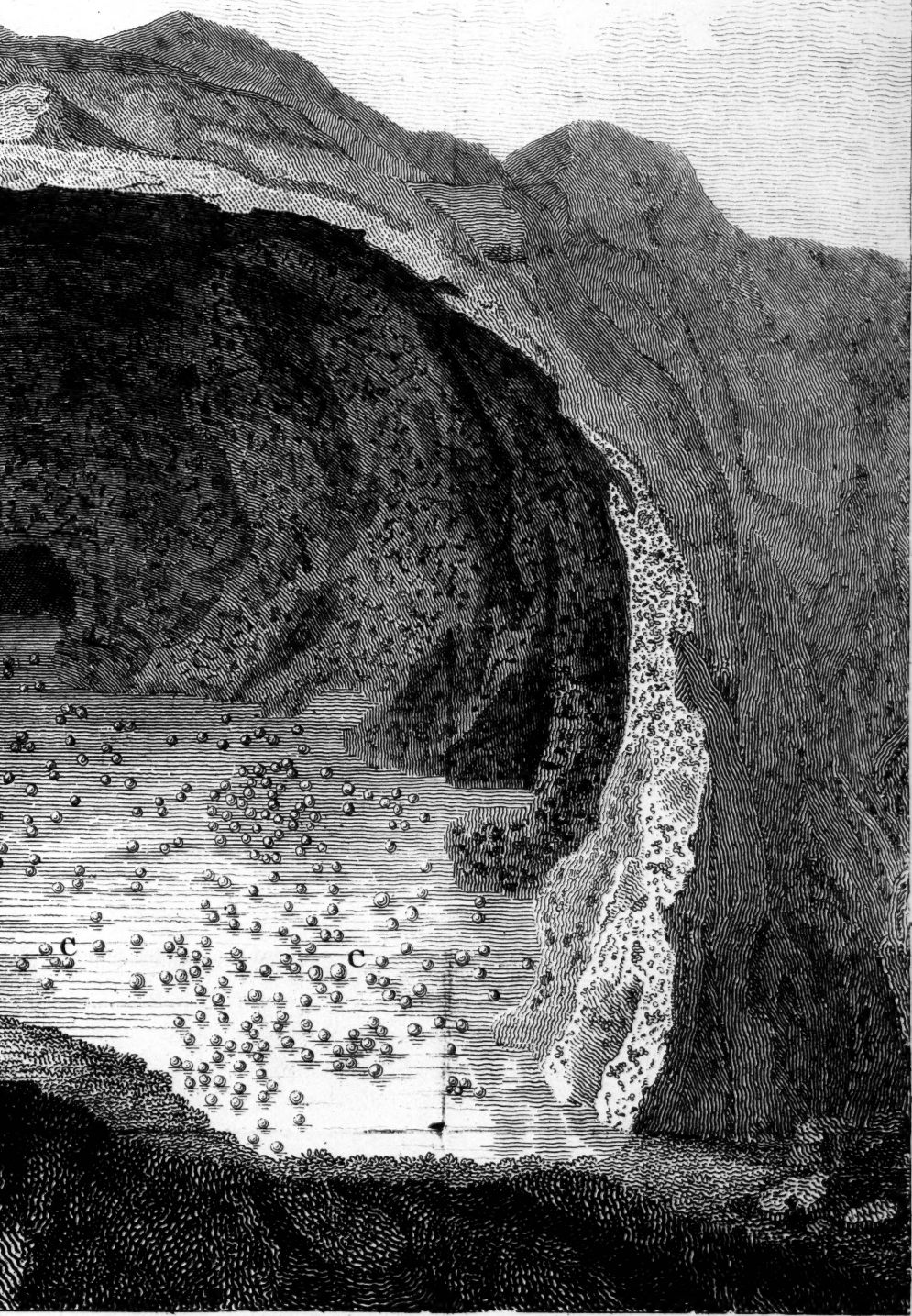


Stromboli



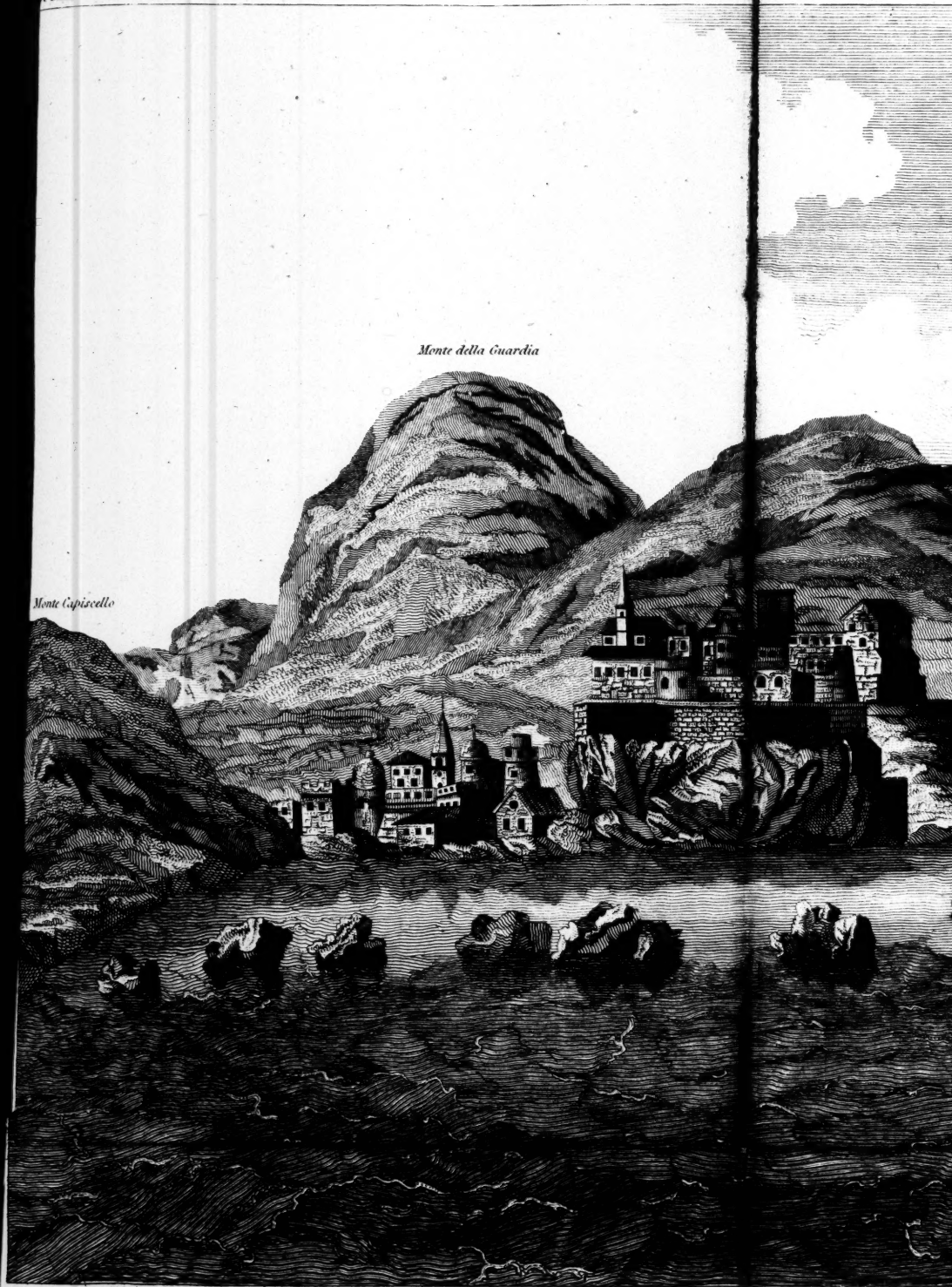


Cavern in the Island

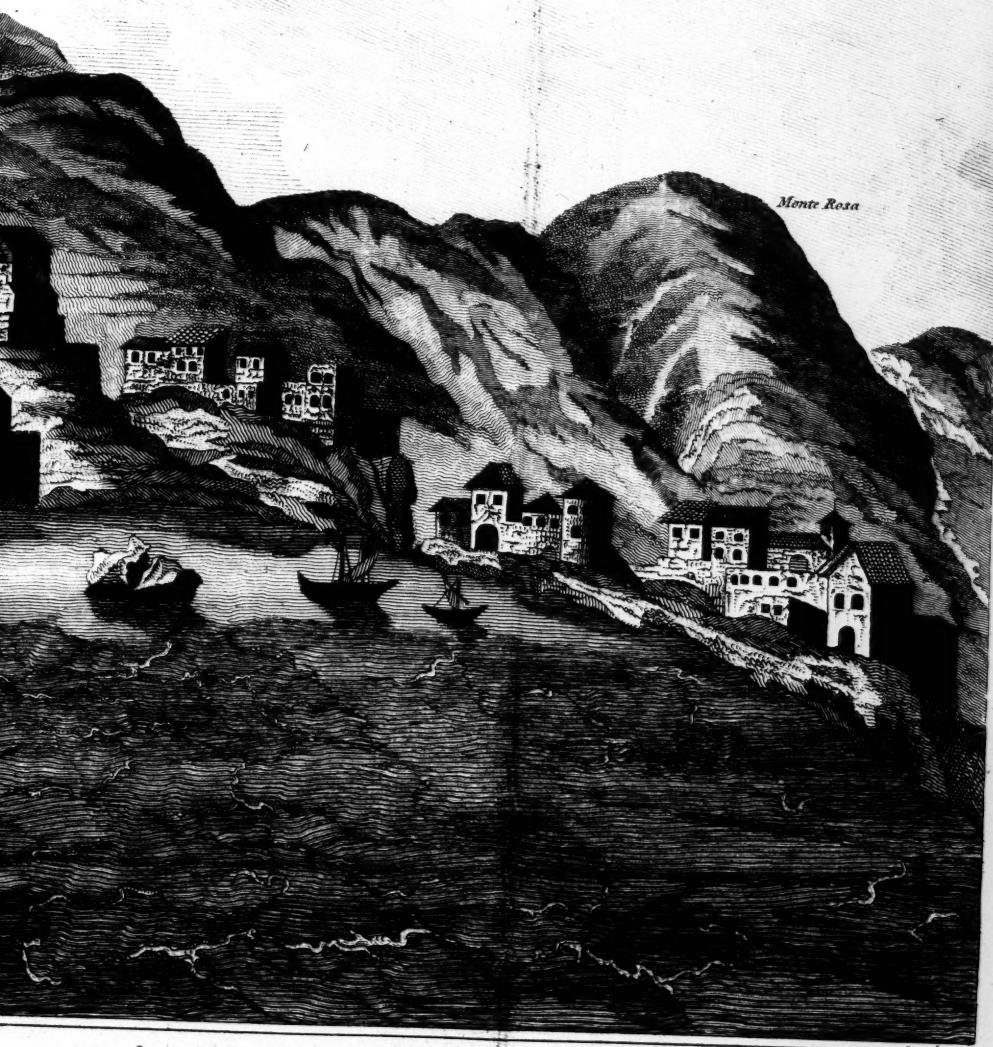


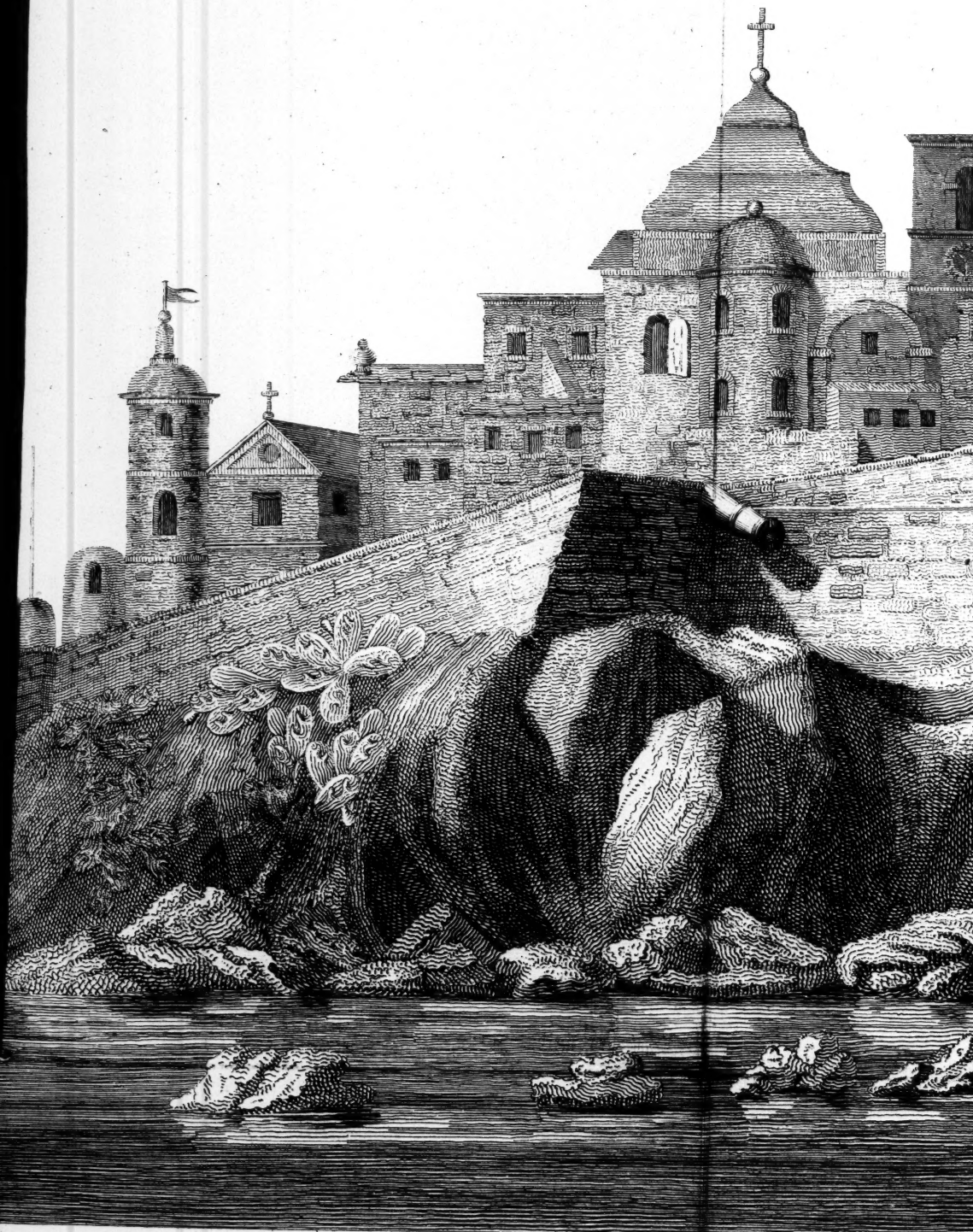
Land of Vulcano.





View of the City of





View of the Castle of



of Lipari.



